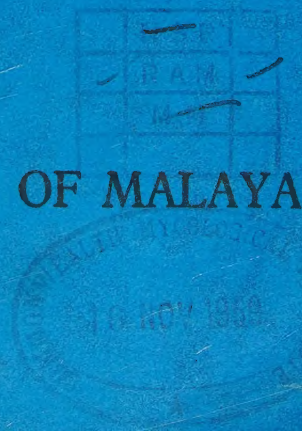


36/E

# ANNUAL REPORT

## 1957

RUBBER RESEARCH INSTITUTE OF MALAYA



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*Price three dollars*



# ANNUAL REPORT

## 1957

### Corrections

#### 1955 Annual Report

Page

- 51 Line 34, for hyposulphate read hyposulphite
- 60 Line 21, for thiazylsulphanamide read thiazylsulphenamide

#### 1956 Annual Report

Page

- 22 Line 43, for or read of
- 69 Soils Division, after G.M.F. Grundy, B.Sc. Soils Chemist read Resigned 31 December 1956
- 69 Statistics Section add G. Chidambara Iyer, M.Sc. Assistant Statistician. (First appointed 20 August 1955)

RUBBER RESEARCH INSTITUTE OF MALAYA

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## *Report of the Board*

Board—The constitution of the Board remained as prescribed by the R.R.I. Enactment No. 14 of 1934 and the members at 31 December 1957 were:

- a The Director of the Institute — *ex officio* — Chairman
- b The Secretary to the Treasury, Federation of Malaya — Financial Member appointed by the High Commissioner
- c The Director of Agriculture, Federation of Malaya — *ex officio*
- d Members appointed by the High Commissioner to represent the interests of smallholders:

The Hon'ble Enche Abdul Jalil bin Haji Aminudin, PJK, J.P.  
Mr Fong Yeok Seng

- e Members appointed by the High Commissioner from a panel nominated jointly by the Rubber Growers' Association, the United Planting Association of Malaya and the Malayan Estate Owners' Association:

Mr J. C. Mathison, O.B.E.  
Mr R. A. Coles  
The Hon'ble Mr A. W. Goode  
Mr J. Brown  
Mr Choo Kok Leong

Of the members under (d) Mr Fong Yeok Seng was appointed for three years from 1.9.55 and Enche Jalil for three years from 1.5.57, on the resignation of Tuan Sheikh Ahmad who had served as a member of the Board from 27 June 1939.

Of members appointed under (e) Mr G. M. Knocker and Mr Gunn Lay Teik were serving at the opening of the year, but the former resigned upon his retirement from Malaya and Mr J. Brown was appointed for three years with effect from 1 May 1957. Mr Gunn Lay Teik resigned upon his appointment as Commissioner for Malaya in Australia, and Mr Choo Kok Leong was appointed for three years with effect from 9 December 1957.

Mr R. A. Coles was on leave for six months and Mr L. Rogers was appointed to act for him. Mr A. W. Goode was on leave for five months and Mr Soon Cheng Sun was appointed to act.

At the close of the year the members of the Board under (a), (b) and (c) were, respectively: Mr C. E. T. Mann, Mr S. Angus and Mr R. G. Heath.

The Permanent Committee consists of five members of the Board:

The Director of the Institute — *ex officio* — Chairman  
The Financial Member — *ex officio*  
Three members appointed by the High Commissioner

At 31 December 1957 the three appointed members were:

The Hon'ble Enche Abdul Jalil  
Mr J. C. Mathison, O.B.E.  
Mr R. G. Heath

During the year the Board held three statutory meetings and two special meetings; the Permanent Committee met six times.



*Policy*—The Report of the Advisory Committee appointed by the Rubber Producers' Council in 1956 under the Chairmanship of Professor G. E. Blackman, Sibthorpian Professor of Agriculture in the University of Oxford, to enquire into Production, Development and Consumption Research in the Natural Rubber Industry, was received by the Council in January 1957.

After full consideration by the Council and its constituent Associations the Blackman Report was published on 22 June 1957. At the same time the Board of the R.R.I. was informed that the Rubber Producers' Council was in general agreement with the main principles set out in the Blackman Committee's Report and requested the Board to consider those recommendations that directly affected the work of the Rubber Research Institute and to prepare plans and submit estimates of the changes in annual expenditure which would result from the implementation of the Committee's recommendations.

The Council further expressed the view that the primary aims of the research work which the industry finances should be the reduction of costs of production and the improvement of quality of the product. Accordingly, detailed plans and estimates of expenditure for the year 1958 were prepared, approved by the Board and submitted to the Rubber Producers' Council and to the Controller of Rubber and the Malayan Rubber Fund Advisory Committee.

The Council accepted the Board's proposals and having considered them in conjunction with plans and estimates submitted by the British Rubber Producers' Research Association and the Natural Rubber Development Board, advised the Federation Government that the rate of cess contribution to the Malayan Rubber Fund should be increased from half a cent to three quarters of a cent per pound. This increase in the cess contribution to research, advisory and technical services became effective from February 1958. The total estimated revenue from the cess in 1958 is about \$10,000,000 (Malayan).

Briefly, as regards the work of the Rubber Research Institute, the Blackman Committee made the following principal recommendations:

i expansion of the work of the Botanical Division with increased attention to improved methods of propagation, the production of high yielding seedling families and further development of the work on yield stimulation.

ii some expansion of the work of the Soils Division more especially in the further study of manuring and cultivation practices, the use of cover plants and the control of weeds by the use of chemical herbicides.

iii review of the existing programme of field experiments on estates and a strong recommendation for the establishment of sub-stations to be owned and operated by the Institute for the future development of the programme of field experiments, this recommendation applying particularly to the field experimental work of the Botanical and Soils Divisions.

iv no changes in the programme of work of the Pathological Division were recommended but emphasis was placed on the importance of research work now in progress on the study of root disease.

v the programme of research work of the Chemical Division was generally approved and the need for close liaison with the British Rubber Producers' Research Association in certain aspects of the research programme was emphasised.

## Report of the Board

The Committee commented strongly on the need for increases in staff concerned principally with Advisory Services, recommending expansion of the present Small-holders' Advisory Service and the setting up of an Advisory Division for service to estates. The objectives must be to speed up progress in research, by reducing the calls on research staff to undertake advisory work, and to increase the efficiency of advisory services by the employment of experienced advisory officers.

All of the foregoing recommendations have been embodied in the Board's proposals and estimates for 1958, except plans for the provision of sub-stations on which action has been deferred until 1959.

The Committee made further recommendations on the need for Administrative changes, first in the R.R.I. Enactment which, under its existing provisions, requires the Director to serve as Chairman of the Board and to be responsible for the day to day administration of the Institute and direction of its research and advisory work. At the close of the year proposals for revision of the Enactment were being considered jointly by the Federation Government and the Rubber Producer's Council.

Other administrative changes recommended by the Committee which concern staff recruitment, terms and conditions of service of all employees of the Board and other related matters were still under consideration by the Board at the close of the year.

*Finance*—Approved estimates of total expenditure and revenue together with statements of actual expenditure and revenue, subject to audit, for the year 1957 are shown below:

|                                        | Approved<br>estimate<br>\$ | Expenditure<br>\$ |
|----------------------------------------|----------------------------|-------------------|
| R.R.I. Headquarters and Laboratories   | 3,741,722                  | 3,703,687         |
| R.R.I. Experiment Station Sungei Buloh | 1,013,826                  | 1,106,902         |

*Revenue*—Estimated revenue for the R.R.I. Experiment Station from sales of rubber and planting material, and refund of cesses under the Rubber Industry (Replanting) Ordinances, as at 31 December 1957 is \$965,063.

It should be noted that the Board receives no allocation from the Malayan Rubber Fund for the operation of the Experiment Station. The R.R.I.E.S. is regarded as a self-supporting unit and all expenditure, including capital expenditure on development of new experimental areas, and for replanting, is provided from revenue. Subject to assistance from the Malayan Rubber Fund in meeting an overall deficit in any year of operation, profits from the Experiment Station are paid into the Malayan Rubber Fund.

*Malayan Rubber Fund*—The relationship between the Board's claims on the Malayan Rubber Fund and those of other bodies financed from the Fund are shown in the analysis, presented below, of the accounts of the M.R.F. for the year 1956 as published in the Federation of Malaya Government Gazette.



## Income and allocations from the Malayan Rubber Fund, 1956 —

| Income                                                                | \$                 | Allocation as %<br>total revenue |      |
|-----------------------------------------------------------------------|--------------------|----------------------------------|------|
| Schedule III —cess @ 0.50c/lb from<br>rubber exported from Federation | 6,672,475          |                                  |      |
| Cess collections Colony of Singapore                                  | 103,092            |                                  |      |
| Interest on investments                                               | 72,326             |                                  |      |
| Interest on bank deposit                                              | 48,363             |                                  |      |
| Sundry revenue                                                        | 11,031             |                                  |      |
| Total income from cess and investments                                | <u>\$6,907,287</u> | ..                               | 100  |
| <i>Expenditure</i>                                                    |                    |                                  |      |
| Administration: Controller's Office                                   | 18,841             | ..                               | 0.3  |
| Contribution to the International<br>Rubber Study Group               | 6,622              | ..                               | 0.1  |
| Rubber Research Institute of Malaya                                   | 3,064,871          | ..                               | 44.4 |
| British Rubber Producers' Research Association                        | 1,573,177          | ..                               | 22.8 |
| Natural Rubber Development Board                                      | 1,837,226          | ..                               | 26.6 |
| Rubber Producers' Council                                             | 93,200             | ..                               | 1.3  |
| Provision for expenses of Blackman Committee                          | 20,000             | ..                               | 0.3  |
| Pan-Malaya Smallholders' Association                                  | 1,789              | ..                               |      |
| Total expenditure                                                     | <u>\$6,615,726</u> | ..                               | 95.8 |
| Balance of Income over Expenditure                                    | \$291,561          | ..                               | 4.2  |

Note—In addition to the amounts received from the Malayan Rubber Fund the Research and Development organisations received contributions as follows:

B.R.P.R.A. £21,855 (sterling) from Ceylon, Brunei, Sarawak, N. Borneo and Nigeria

N.R.D.B. £ 7,203 (sterling) from Brunei, N. Borneo, Sarawak and Nigeria

Contributions received by the R.R.I. from Brunei, Sarawak, North Borneo and Nigeria do not appear separately in the accounts, being automatically deducted from the Board's allocation from the Malaya Rubber Fund.

*Research programme and estimates 1958*—The Board submitted detailed programmes of work for the year 1958 and estimates of expenditure totalling \$5,508,980 to cover the approved programmes. The Estimates were accepted by the Controller of Rubber and a contribution of the above amount approved from the Malayan Rubber Fund. Approval was subject to such further revisions that may be needed in 1958 to implement the recommendations made by the Blackman Committee and referred to the Board for adoption.

The general programme of research for the period 1958-1962 was prepared, as stated above, in accordance with the recommendations made in the Blackman Report and in accordance with the views expressed by the Rubber Producers' Council that the main objectives shall be reduction in cost of production and improvement in quality of the product.

The detailed programme for 1958 provides for the winding up of certain lines of research and the commencement of new projects with provision for additional research staff, especially in the Botanical Division, and for senior staff for the expanded Advisory Divisions.



## Report of the Board

The estimates submitted for 1958 provide for the first year of re-organisation and were accepted on the understanding that additional funds would be required for the new developments envisaged in 1958 and later, when detailed plans have been prepared and submitted by the Board.

*Staff and conditions of service*—The senior staff position has remained fairly stable during the year; three senior officers resigned and three others were engaged. At the end of the year there were nine vacancies for senior staff and although the posts had been advertised the response from adequately qualified applicants was very poor. The total senior staff posts to be filled in 1958 is eighteen as at 1 January 1958.

Regarding junior staff the position was good and the Institute had no difficulty in attracting recruits with very good school qualifications. In the Smallholders' Advisory Service recruitment was limited by the facilities for training of Diploma students in Agriculture at the College of Agriculture, Serdang.

In commenting upon the employment of research staff the Blackman report emphasised that it will be necessary to depend for some time upon recruitment of specialist officers from overseas until qualified Malayan officers, who are attracted to research appointments, become available. At the same time the Committee recommended that the salary scales and conditions of service for all of the Board's employees should be reviewed.

The Board appointed a special Committee to examine the full implications of these recommendations. Meantime, with the support of the Rubber Producers' Council and approval of the Controller of Rubber, the Board made an interim revision of salary scales of senior research, advisory and administration staff, amounting to 20% of total pay, as from 1 January, 1957. It is expected that the Board will complete the detailed review of staff reorganisation, salary scales and conditions of service early in 1958.

C. E. T. MANN

Chairman of the Board

# *Report of the Director*

## *Review of Research and Advisory Work*

**Research**—During 1957 the programme of research approved in 1956 was generally followed, but during the second half of the year, after the receipt of the Blackman Report there were changes in priority in some lines of work and others were reduced to essentials or deleted from the programme. Much of the time of the Director and Heads of Divisions was spent in the detailed review of current programmes and the preparation of revised plans in accordance with the recommendations made by the Blackman Committee and with the wishes of the Rubber Producers' Council.

In the revision of the research programmes of the biological divisions, Botany, Soils and Pathology, valuable advice and assistance was generously given by members of the Agricultural Sub-Committee of the London Advisory Committee for Rubber Research.

In the revision of the Chemical Division programme, the Head of the Division, on leave in Europe during most of the second half of the year, was able to revise his programme of research 'on the product' in consultation with the Director of Research of the B.R.P.R.A., with the staff of the N.R.D.B. and with others, so that plans for the closer liaison advocated by the Blackman Committee have been provided for in the future programme of work of the Chemical Division.

Among the recent advances made in research during 1957 are the following:

- a Confirmation from large scale trials of the value of a number of the RRIM 600 series clones, notably RRIM 600, 603, 605, 607, 610, 614 and 623 of which certain clones during the first and second years of normal tapping have yielded up to 1000 lb per acre.
- b Further development of yield stimulation techniques, either alone or in conjunction with 200% tapping on mature seedling and budgrafted trees, resulting in large and economic increases in yield.
- c Accumulation of further evidence that under present day conditions, with the rapid advances in replanting, mature rubber has been undertapped and is generally capable of giving higher economic yields than have been obtained in the past.
- d Best results from manuring of rubber on inland soils are obtained from fertiliser mixtures containing nitrogen, phosphorus and potassium. On modern high-yielding rubber, experiments have indicated that the maximum benefits from nitrogen manuring are not obtained in many cases without the addition of potash.
- e Good progress has been made in the trial and development of economical methods of selective weed control by the use of chemical sprays.
- f Improvements in standard procedures for the identification and control of root disease have been established and their use reduces the cost of control.
- g Fundamental research on root diseases and their control is pointing the way to new possibilities for their control.

The above mentioned advances are all in the agricultural field; they are not recorded in order of economic importance.

In research on the product, processing and preparation of rubber and latex for delivery to the consumer, the following advances are mentioned:



## Report of the Director

- h Biochemical studies of the non-rubber constituents of latex have already been applied to improve quality and further improvements are indicated.
- i The microbiological study of latex before, during and after its flow from the tree has resulted in improved quality of the latex and the discovery of a promising new method of yield stimulation.
- j Means have been discovered to obtain highly increased chemical activity of the rubber hydrocarbon in latex fresh from the tree and to utilise such activity in the preparation of valuable new modified rubbers by graft polymerisation.
- k Vigorous application to the development of modified dry rubbers has resulted in rapid expansion of production of 'SP', superior processing, rubber.
- l Good progress has been made in the development of latex concentrate preserved with new systems containing low concentrations of ammonia.

All of these advances are described more fully in the Divisional reports below.

*Statistics Section*—Although it has suffered a great loss with the resignation of Mr D. R. Westgarth in May 1957 it has continued to provide invaluable service to the Research Divisions in the statistical analysis of data from field and laboratory experiments. The results of such analyses were embodied in 160 reports to the various divisions.

Designs for fourteen new field experiments were prepared. In this connection, five visits to estates and three to the Experiment Station were made. Six requests for statistical advice from outside the Institute were answered.

The Power-Samas punched card installation was completed by November. The Statistics Section took over from the Soils and Botanical Divisions the task of summarising girth and yield data from field experiments.

*Advisory services*—The demand for advisory services has shown a steady increase over 1956. A notable feature has been the increase in the number of enquiries from the smaller estates largely locally owned under Malayan management or family operated.

This section of the estates group, with the increase in replanting activity, is beginning to use the Institute's services more freely. These welcome demands underline the need for rapid expansion of the new Advisory Division for estates. The demands will be met by further expansion of the Smallholders' Advisory Service and extension of the duties of Rubber Instructors, more especially Chinese Instructors to cover the needs of the smaller Malayan-owned estates.

The principal subjects of enquiry and investigation in course of advisory work were:

- a The choice of planting material.
- b Selection and checking of sources of supply of reliable clonal seeds for use in replanting.
- c Advice on modified tapping systems and the use of yield stimulants.
- d Manuring in replanting and manuring of high yielding young mature rubber in bearing.
- e Control of cover plants and weeds by means of chemical sprays and other forms of herbicides.
- f Control of root diseases especially in replanting.

- g Control of cover plant pests including locally destructive outbreaks of the cockchafer pest.

In the province of the chemists and rubber technologists the principal subjects on which advice has been sought have been:

- h Assistance in the control of quality of latex concentrates. By far the heaviest volume of enquiries relate to this subject.
- i Maintenance of quality and uniformity of standard sheet rubber through the Technical Classification scheme.
- j Advice on smoke houses and other forms of drying installations for sheet and crepe.
- k Advice on factory lay-out, sanitation and latterly, the disposal of factory effluent and recovery of waste rubber.

The special problems of smallholders are referred to in the report of the Smallholders' Advisory Service which follows the reports of the research Divisions.

*Publications and Library*—*Planter's Bulletin* has been published regularly and on time and has continued to gain a gratifying reception from planters and others both within Malaya and from other countries for which the subscription list exceeds 1000 members. It is recorded with regret that Mr D. R. Rexworthy, who has been chiefly responsible for the production of *Planters' Bulletin* over the past five years, resigned and left Malaya in December 1957. Since Mr Rexworthy's departure Dr A. Newsam has undertaken the production of the *Bulletin* in addition to his duties as Head of the Pathological Division.

The *Journal* of the RRIM continued publication in a new and much improved format in 1957; three parts of Volume 15 were published during the year containing Journal Communications 301 to 314.

The Smallholders' Advisory Service published two handbooks for smallholders — 'Replanting on Smallholdings' (in Jawi text) and 'Good Tapping' (in English, Jawi, Rumi and Chinese).

During the year work on re-organisation and the preparation of a new catalogue and reference system has been undertaken by Miss M. M. Sullivan and 'Che Maulud bin Undah.

*Liaison*—The RRIM has continued to maintain liaison with other organisations financed from the Malayan Rubber Fund and with Research Institutes for rubber in other countries. The Institute has also given direct assistance to Thailand and Burma in developing plans to assist rubber growers in those countries.

The RRIM continued as a member unit of the International Rubber Research Board and International Rubber Development Committee. In view of the progressive decline in Indonesian-Netherlands participation in the activities of the IRRB/DC, the future of the organisation will be reviewed during 1958.

The Director R.R.I. attended the meetings of the International Rubber Study Group held at Jogjakarta in Indonesia in June 1957, having been nominated as Observer for the International Rubber Development Committee.

*Reports of Divisions and Sections*—Brief reports from the main Divisions and Sections of the Institute follow below.



# Report of the Director

## SOILS DIVISION

### Research

**Manuring of hevea**—Growth and yield records obtained from field experiments during the year confirm earlier conclusions and there are no important new developments to report. It is firmly established that rubber trees growing on inland soil types respond to fertiliser treatments at all stages of growth. The magnitude of the response varies on different soil types but the general pattern of effect has been much the same in all trials on inland soils. There is always a marked response to phosphate applied in the planting hole at time of planting. Further additions of phosphate have little effect in the first two years after planting and, during this period, the main effect is due to applications of nitrogen. In the third and subsequent years there is usually a marked response to further applications of both nitrogen and phosphate. The effect of potash is less consistent, but a positive response to treatment with potash was established in some areas and the recommendation to use mixtures containing nitrogen, phosphorus and potassium for manuring of immature rubber areas on inland soils appears to be justified.

No firm evidence of a response to fertiliser treatment in young replanted areas on coastal alluvial soils has been obtained. New field experiments on coastal soils were started during the year.

In regard to manuring of mature rubber areas the results of experiments show that, on inland soil types, best results can be expected from treatment with fertiliser mixtures supplying nitrogen, phosphorus and potassium. The evidence suggests that the beneficial effect on growth and yield increases with increasing levels of nitrogen, but a similar upward trend with increasing levels of phosphate is not clearly apparent. Yield response to nitrogen is greater in the presence than in the absence of potash but again there is no evidence of increased effect due to increasing levels of potassium.

For mature rubber areas on coastal alluvial soils the evidence available now suggests that applications of a nitrogenous fertiliser only may be regarded as an effective treatment although the possibility that there may be an advantage from the addition of a potash fertiliser is not ruled out.

**Cultivation and ground covers**—As part of the programme to study the nutritional requirements of leguminous creeping covers work was carried out to develop and identify symptoms of nutrient deficiency shown by *Centrosema pubescens*. Marked symptoms of boron and zinc deficiency were produced at a very early stage in the growth of the plants and development of the young seedlings was severely retarded. Symptoms of deficiency of the other essential nutrient elements developed at later stages and were recorded.

Weed eradication work was restricted mainly to testing new herbicides for control of grasses and to exploring the possibility of eradicating *Mikania scandens* growing amidst legumes.

For control of grasses, including lalang, best results were again obtained with Dowpon. This weedkiller also kills bracken and sedges (*Scleria* sp.); little or no recovery was observed in the trials up to 12 months after treatment at the rate of 20 lb per acre.

Of the other new herbicides tested for control of grasses, Aminotriazole gave the most promising results. The effect of applications at the rate of 15 lb per acre compares favourably with that produced by spraying with Dowpon at the rate of 10 lb per acre. For killing bracken and sedges it is just as effective as Dowpon.

Bertam palm, commonly found in jungle clearings, can be killed by spraying with Lallicide at the rate of 8 ounces in 2 pints of water per clump. Dowpon at the rate of 4 ounces in 2 pints of water was only slightly less effective while solutions of Amino-triazole and C.M.U. at similar concentrations were comparatively ineffective.

Several small scale trials were carried out the purpose of which was to find out if *Mikania* growing amidst legumes could be selectively eliminated without injury to the legumes. Two out of five treatments have given encouraging results and it would appear that the problem of preventing volunteer growth of *Mikania* from swamping out a cover of leguminous creepers may be solved without resort to the costly method of hand weeding. Further trials, on a larger scale, are in progress.

*Soil investigations*—Laboratory studies on mineralisation of soil nitrogen were continued. There are indications of a marked increase in nitrification in the soil after land has been cleared of jungle and planted with rubber. Levels of up to 100 p.p.m. nitrate nitrogen were found in the topsoil of a new clearing compared with levels below 10 p.p.m. in jungle-covered soils nearby.

The nitrogen status of soil under different types of ground cover is being studied. Preliminary results show a higher level of ammonium-nitrogen than of nitrate-nitrogen at all depths down to 3 feet below the surface under each of three covers tested — *Pueraria*, *Mikania* and grasses. The content of nitrate-nitrogen is rather higher in soil under *Pueraria* than under the other two covers.

*Plant investigations*—The effect of light and mineral status on rubber formation in the rubber plant was studied. Results show that the rubber content of young seedlings is closely correlated with their dry weight, carbohydrate and protein contents. As light intensity exerts a greater effect on these values than does nutrient status, variation in the latter is of lesser importance than light as a factor in the formation of rubber. The effect of mineral status of the plant on rubber formation is an indirect effect, and is concerned with the role of nutrient elements in the formation of either carbohydrates, proteins or plant dry matter. Traces of micronutrient elements would appear to be important in this respect. The interpretation of results is made easier if rubber is regarded as a by-product of growth rather than as a food reserve.

The results of an experiment designed to study the relationship between mineral nutrition of the rubber plant and its susceptibility to infection by *Helminthosporium heveae* suggest that the increased susceptibility at higher nitrogen levels may be associated with the reduction in the phosphorus and potassium concentrations within the laminae.

#### Advisory Work

No important new trends in advisory work were noted. As in previous years manuring of immature and young mature rubber was the subject which arose most frequently among a variety of enquiries. It would seem that regular manuring of young high yielding mature rubber is becoming more widely accepted as a policy meriting consideration and the need for manuring was more readily recognised when attention was drawn to symptoms of nutrient deficiency manifested by leaf discoloration. Several enquiries concerning leaf discoloration were received following publication of *Journal Communication* 300 in which deficiency symptoms were described and shown in coloured photographs. Magnesium deficiency is widespread, particularly in immature areas and attention was drawn to several mature rubber areas where potash deficiency was diagnosed. It is becoming increasingly evident that potash deficient soils are much more widespread than was thought, particularly in the north.



## Report of the Director

Clear symptoms of manganese deficiency were observed in several areas, none of which covered a large acreage. It has been shown that this can be corrected by applications of small amounts of manganese sulphate. Symptoms of iron deficiency also were observed in a few, relatively small scattered patches on light, highly leached soils, but judged on field observations to date it would appear that trace element deficiency is not a major problem in rubber areas of Malaya.

### BOTANICAL DIVISION

#### Research

*Breeding and selection*—Eight thousand eight hundred and ninety hand pollinations were carried out in 1957 representing eleven different crosses. Nine hundred and ninety-five seedlings were obtained. Five of the families were crosses with the *Dothidella* resistant clone FX 25, using pollen only from the latter.

Four hundred and seventy-two new clones were made from the 1955 hand pollinated seedlings and were budded in a simple lattice design field trial. Owing to shortage of space one hundred and forty-eight clones were budded in the nursery for future use.

Seven hundred and twenty-three seedling stumps were planted out of the 1955 hand pollinated seedlings and nine hundred and ninety-five basket plants of the 1957 hand pollinated seedlings were planted. Both these series were planted in two single tree plot designs, with Tjir 1 illegitimate seedlings as controls.

A trial to compare the value of seedling families from the Smallholders' seed gardens at the R.R.I. Experiment Station was also set up. Other seedling families that showed promise were included.

In the trials to compare ninety-one clones from South East Asia (the Exchange Clones), the four lattices of all trials were budded and lattices A, B and C were cut back by the end of the year.

Two of the distributed block trials of the RRIM 600 series clones on estates were opened for tapping in 1956 and completed their first year of tapping in December 1957. Eleven further blocks on estates were opened for tapping during the year. Most of those remaining are expected to be brought into tapping during 1958.

The second of the postwar RRIM 500 series clones trials was opened for tapping on 1 May 1957. The first trial completed its first year of tapping during the year.

At the R.R.I. Experiment Station the second year of tapping of the large scale trial of clones RRIM 600 - 618 was completed at the end of September. Clone RRIM 613 was the highest yielder but at the end of the tapping year had suffered a large number of casualties by wind break. In combination with other characters the promising clones at the end of the second year appeared to be RRIM 600, 603, 605, 607, 610 and 614. The yield records have been tabulated and at the end of the year were submitted for statistical analysis. The results will be published.

The first year of tapping of clones RRIM 619 - 630 in large scale trial at the R.R.I. Experiment Station was completed by the middle of the year and the records, adjusted for block effects, were prepared for publication in the *Planters' Bulletin* as early as possible in 1958. RRIM 623 appears to be most promising in these trials on yield and secondary characters.

All large scale trials on estates were visited by field assistants, and girth measurements and other observations were made.

*Propagation techniques*—In investigations of stock-scion effects in buddings of hevea and in part connection with the programme of investigations of disease resistance, the panel clones were budded in a large scale field trial to study the effects of nine *Dothi-della* resistant clones top budded on three high-yielding Malayan clones.

With the ultimate objective of the possibility of large scale propagation of clones on their own roots and the production of clonal root stocks, new work has been done on the propagation of hevea from leaves and young shoots. Early results are most encouraging.

*Tapping experiments*—Tapping experiments on clone G1 I showed that third daily tapping of a half spiral cut was the most economical system. Brown bast incidence was low and the yield per acre was similar to that of tasks tapped alternate daily on a half spiral cut in the fourth year of tapping.

A similar experiment was in progress during the year on clonal seedlings. In this experiment the effect of a yield stimulant on brown bast incidence was also examined. The yield stimulant had such a depressing effect on the growth of the young seedlings that the treatment had to be dropped, to avoid severe damage.

In another experiment alternate and third daily tapping of half spiral cuts were compared on young trees of clone PB 86, confounded with stimulant application and two manuring treatments. Sufficient results for comment are not yet available.

Intensive tapping experiments continued on old unselected seedling trees which, after two and a half years of 200% intensity tapping, did not show any sign of interaction between the cuts or decline in yields. Combinations of this tapping system with periodical application of a yield stimulant proved very productive.

High yields were recorded during the year, after two and a half years of 200% tapping, of twentyeight-year-old budded trees of nine clones. Signs of interaction between cuts became apparent, but no increase in brown bast incidence was observed. The high cuts were successfully brought through the virgin bark island with the aid of the yield stimulant, applied at intervals of four months.

Three long term experiments on stimulation of yield, the oldest of which is now six years old, were continued. Two new experiments were set up on seventeen-year-old high-yielding buddings and tapped on bark of first renewal. Intensive tapping systems of 133 and 200% intensity have also been included in these experiments.

Three field experiments were set up in cooperation with the Chemical Division, to test the effects of various yield stimulation treatments on the yield and quality of latex. Sufficient results were not available at the end of the year to make any firm report.

*Physiological investigations*—A series of screening tests for plant growth substances was set up at the R.R.I. Experiment Station and a number of substances were applied at monthly intervals, above the tapping cut of young buddings of PR 107 and AVROS 352. The effects on yield and bark renewal were followed for six months. The results indicated that 2,4-dichloro-5-fluorophenoxyacetic acid has an effect comparable to 2,4,5-trichlorophenoxyacetic acid, while 2,4-dichlorophenoxyacetic acid shows a somewhat lower level of activity. 2,4,6-trichlorophenoxyacetic acid, diphenyl urea and coconut milk concentrated by freeze-drying were inactive. The substances active in yield stimulation caused swelling and cracking of renewing bark, whereas the inactive treatments caused little change in the rate of bark renewal.

Eleven compounds prepared and supplied by the Department of Agriculture of the University of Oxford, were put into large scale test at the Experiment station on mature



clonal seedling trees. Owing to the theft of the first set of cup samples in pre-recording, the experiment was delayed in starting. At the end of the year sufficient information was not available to enable comment to be made.

The effects of gibberellic acid on seed germination, seedling growth, shooting of buds and latex flow were subjects of a series of experiments commenced in 1957 and still in progress at the end of the year. The results to date have been disappointing. Further information has come to hand that for certain effects it is necessary to employ an extremely high concentration of the acid.

Experiments in the laboratory at the Experiment Station over a wide range of concentrations failed to show any effect of the potassium salt of 2, 4, 5-trichlorophenoxyacetic acid on the water content of hevea bark disks in water, sucrose, or mannitol solutions. In a parallel series of experiments, however, the application of 1% 2,4,5-trichlorophenoxyacetic acid to patches of scraped bark of mature seedling trees caused increases in water content of 1–6% compared with control patches on the same trees. Analyses of reducing sugars and sucrose failed to show consistent differences between treated and untreated bark.

The high activity of naturally-occurring indole compounds in yield stimulation led to interest in the natural auxin content of latex. Despite the reported occurrence of indole-3-acetic acid in hevea leaves, it has not been possible to demonstrate its presence in latex, using similar methods of paper chromatography and the *Avena* straight growth test. At least one active substance, as yet unidentified, has been shown to be present.

*Ecology (cover plants)*—The two cover plant experiments established at the R.R.I. Experiment Station in 1956 have been selectively weeded and desired species supplied, so that virtually pure covers according to treatment have been achieved. One of the trials has been budded with clone GT 1.

Portions of a replanting at the R.R.I. Experiment Station have been planted with grass and legumes respectively, to enable investigations of the effects of mowing and special manuring to be investigated in a split plot design. Creeping legumes and a shrub legume, *Flemingia congesta*, form the covers in the remainder of the field. A creeping legume with considerable promise in view of its good seed set under local conditions and a measure of shade tolerance, has been identified as *Clitoria rubiginosa*.

Gibberellic acid concentrations of 0, 1, 10 and 100 ppm were confounded with pretreatment by cutting the seed coat, and no pretreatment, in germination tests on seed of four leguminous cover species. In all species, pre-treatment by cutting gave highly significant increases in germination, but only in the case of *Flemingia congesta* was an additional advantage obtained due to gibberellic acid after pretreatment by cutting. For seeds which did not receive cutting pretreatment, 10 ppm of gibberellic acid led to significantly low germination relative to control in *Centrosema pubescens* and *Pueraria phaseoloides*. No other significant results were obtained, although in *Calopogonium mucunoides* 10 ppm of gibberellic acid gave the best germination without pretreatment and the worst after cutting. In that no significant improvement in seed germination without cutting pretreatment was obtained over the range of concentrations studied, gibberellic acid appears to be of no value for practical use in this field. Other investigations into improving the germination of cover plant seeds were continued.

Work on the collection and recording of plants for the herbarium was held up by lack of staff.

### Advisory Work

A further 25% increase in general correspondence was noted during the year. The increase in correspondence was solely on the Advisory side and is now nearly three times the amount noted in 1955.

Work solely on the inspection of areas suitable for recommendation to the Boards of Administrators of the Government Rubber Replanting Schemes as potential clonal seed collecting areas, occupied Inspectors for four hundred days in visits to one hundred and ninety-six potential seed collection areas on estates. A small proportion of this time was spent in checking the identity of budwood in nurseries and field. The total acreage approved for clonal seed collection as at 15 December 1957 was 21,153 acres on one hundred and sixteen estates.

A Clone Inspector visited eighteen estates and agricultural stations over thirty-seven days in North Borneo, in order to inspect clonal seed collection areas and budwood nurseries. A Clone Inspector paid a rapid visit to Medan, Sumatra in the last month of the year to verify the identity of an exchange clone. He was successful in his object in spite of disturbed conditions.

Research Officers made sixty advisory visits to estates, and eighty visits to estates in connection with research work; a total of one hundred and forty. Most of the research visits also involved some advisory work. Field assistants made two hundred and two visits to estates in connection with experiments, spending six hundred and seventy-one days.

One hundred and sixty-six visits were made to the Rubber Research Institute Experiment Station by Senior Officers in connection with work at the Station.

Seed of *Flemingia congesta* was distributed to twenty-three estates. One hundred and twenty-two commercial samples of cover crop seeds were tested throughout the year. Naturally occurring plants were identified for twenty-four estates.

### PATHOLOGICAL DIVISION

#### Research

**Root diseases**—The spread of white root disease on the roots of artificially inoculated trees has been followed over a period of a year both when the rhizomorphs were allowed to grow unhindered and when external growth on the roots was suppressed. The rate of progress of the disease was so slow in the absence of external growth that the trees were to some extent able to resist further invasion; in some instances the infection was cut off and the wound started to heal over. These findings have led us to intensify our search for a material that will prevent external growth of root parasites on the roots. With the same objective, manufacturers of fungicides have been invited to furnish, for further testing here, substances which might be expected to retain their activity when used as a soil drench.

Of our long term field experiments on estates, one (G 50) laid down in 1950 has been terminated; two (Cl 51 and Cl 56) are being continued, while two new experiments (SR 57 and J 57) have been started. Experiment G 50 has confirmed the superiority of the recommended method of stump poisoning with sodium arsenite — by applying a paste to the ring barked top of the stump. Experiment Cl 54 has shown little difference between the effectiveness of sodium arsenite and normal butyl 2,4,5-T, as judged by the rate of death of the roots of poisoned stumps and trees which were later felled. The experiment is designed to compare the resulting incidence of root



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disease in the replanting, following each treatment. Experiment CI-51 has shown that routine control measures that have long been advised, though eliminating root disease in the end, have meanwhile the undesirable effect of increasing the incidence of infection on the replanted stand. Periodic tree-to-tree collar inspection during immaturity has, accordingly, been dropped from our recommendations. The two new experiments have been put down to investigate methods of eradicating diseased trees from the old stand prior to replanting, and the effects of surface timber in spreading root disease. SR-57 is sited on alluvial clay where white root disease is dominant, while red root disease is dominant on the inland soil of experiment J-57.

A fundamental study of the root diseases is proceeding. Fructifications of the three major root disease fungi are being studied microscopically to help resolve doubts as to their identities. Even the name *Fomes lignosus* is dubious and will have to be changed or the species redescribed in due course. Isolates of white root disease from many sources have shown physiological differences in culture.

More than 3,600 returns were received from the Rubber Industry (Replanting) Board in connection with their survey of the root disease position on Smallholders' 1953 replantings, which we suggested, in consultation with the Smallholders' Advisory Officer. Analysis of the data has been delayed by the Power Samas installation not being ready.

Sodium arsenite, applied as a paste after ring barking, has been compared with butyl 2,4,5-T, brushed on to intact bark, as a stump and tree poison. Poisoned trees were not left standing but were felled at various periods after poisoning. Differences between the two poisons were not evident from the rate of death of the roots. Though both methods are used with success to poison standing trees, felling treated trees at intervals after poisoning progressively reduced the effectiveness of the poisons. Notwithstanding these findings, erratic results are sometimes reported when 2,4,5-T is used on estates. Alternative poisons tested have given disappointing results. On the other hand, the indications are that more extensive coverage of the bark, using a more dilute solution, may give better results. Also, addition of boric acid to 2,4,5-T has given a strikingly more rapid kill, leading to earlier decay.

A start has been made with an investigation of the rate of decay, and of the organisms causing decay, of rubber timber. One approach is partly experimental, using insecticides to restrict the insect population, for comparative studies. The other approach is to observe the state of decay reached by timber under various conditions. In an area where old rubber trees were felled after poisoning and were soon covered by a heavy growth of creeping legume cover, it was estimated that 20% of the wood was broken down to humus in one year; 60% in two. Decay was due mostly to fungal attack.

**Panel diseases**—Following up the work done at Long Ashton Research Station, for the RRIM, on the fungicidal activity of tar oil fractions, a commercial producer sent five fractions for evaluation against mouldy rot. Only one reached the standard required for a fungicide to be approved, the limiting factor being their toxicity to newly tapped bark. A proprietary tar acid fungicide sent for testing by another manufacturer has been approved, while two others have been under test.

**Leaf diseases**—The annual survey of secondary leaf fall has been carried out as usual on specimens sent in response to a circular to estates and Rubber Instructors. A new approach is being made to the control of bird's eye spot with fungicides, this time using a motor driven mist blower of improved design.

**Branch diseases**—A study of pink disease is proceeding, with emphasis on its dissemination. The nature and time of spore production are now fairly well understood, but repeated attempts to bring about artificial inoculations with spores have still not succeeded, even though applied to the branches of the highly susceptible clone RRIM 501. A census of infected trees has been carried out on the Experiment Station to observe differences in clonal susceptibility, and to relate the incidence of disease to fertiliser treatments. No effect of phosphorus or potassium was found, but with an increase in the level of nitrogen the incidence of disease was higher. A new synthetic fungicide has been found to be about as effective for pink disease treatment as is Fylomac 90, to which it is chemically related.

**Pests**—Observations on the persistence in soil of chlorinated hydrocarbons, some of which are very effective in controlling termites, have been in progress for several years and are approaching completion. The study of their activity in peat, which rapidly inactivates even the best of them (aldrin and dieldrin) at dosages which are fully effective in other soils, is being pursued at much increased dosage rates. The same kind of treatment — watering the soil with aqueous emulsions — has been tried against cockchafer in one outbreak area, to compare gammexane and aldrin. The former gave a more complete kill of the grubs, but it is to be expected that aldrin will persist longer in the soil. Insecticide applications designed to protect scorched trees from invasion by boring beetles have been unsuccessful. It appears that the parts of the tree penetrated by borers are already damaged beyond recovery, and that the beetles do not make the condition any worse. Tests with insecticides against pests of covers have shown DDT to give good results against ladybird beetles, while endrin is preferred for treating caterpillars. Cross inoculation tests with eelworms derived from five common legume covers have shown that they comprise four distinct strains or species, with different host ranges. One of them was able to penetrate the roots of rubber seedlings planted in infested pots.

#### Advisory Work

The amount of advisory correspondence has, over the last few years, progressively fallen off. In 1957 half as many enquiries were dealt with by correspondence as in 1956. This is regarded as an effect of the steadily increasing coverage of the subject by articles in *Planters' Bulletin*, which is the best medium for presenting generalised advice. Specific problems are best dealt with by inspecting the affected area. The number of advisory visits to estates has increased over last year, it will rise further because managers of estates are being encouraged to ask for a visit when they are confronted by a pathological problem.

There have been the usual requests for identification of fungi suspected of causing root disease. Harmless saprophytes that produce white rhizomorphs can be mistaken for white root disease, unless penetration of rubber roots is taken as the guide. Another error sometimes made is to regard any bracket fungus as indicating a source of infection. The root parasites can be identified from their fructifications, but it is preferable, in the field, to take account only of those sources traced back from infected trees. Most of the other enquiries concerned control measures in replantings, on which subject our views have been undergoing a change in the light of experimental findings, and on the effects of preplanting eradication of sources of disease. Some interest has been taken in control measures in older rubber, where the choice between trenching to isolate disease patches, or treating the disease, is not easy to make.

Another possible solution that has been considered but not investigated is to poison trees bounding disease patches. Other root disease subjects raised included the effects of different methods used to clear old rubber, and of leaving timber on the ground



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in a replanting. Field Assistants have carried out root disease inspection work or demonstrated control measures on a few estates — this being a service that we plan to expand.

A harmless mould growth that forms on the renewing bark of panels treated with Fylomac 90 is sometimes mistaken for uncontrolled mouldy rot. It is thought that terminal branch dieback which requires no treatment, may sometimes have been mistaken for pink disease. The importance of correctly identifying disease symptoms has led to the production of a descriptive manual, which is with the printer.

A report of poor seed set in a seed garden having drawn attention to the inadequacy of our knowledge of the effect of pest and diseases of flowers, plans have been made for regular observations of flowers, and for a dusting experiment, to be made during the next flowering season.

In addition to the usual reports of localised outbreaks of various pests, two new ones have been recorded: lac insects on the branches of buddings five years old; cockchafer beetles eating the lower leaves of young seedlings. There have also been a few locally serious outbreaks of cockchafer grubs. Pests attacking legume covers have been more than usually troublesome. A severe drought, which was widespread early in the year, in a few localities led to death of the bark on the trunk of clones Gl 1, RRIM 501 and PB 6/9.

The demand for packaged *Rhizobium* compost culture for inoculating seed of legume covers has continued to increase. More than eleven thousand packets were distributed.

### CHEMICAL DIVISION

During 1957 shortage of senior staff continued to hinder progress in Chemical Division particularly on the technological side. Throughout most of the year there were three vacancies for research officers unfilled. The Head of Division was absent on long leave and special duty in London from April to December 1957.

#### *Basic Research*

*Biochemistry of latex*—Considerable progress has been made on research projects. In the biochemical field, examination of certain latex fractions has established differences between latex from different clones in respect of protein content; at present the differences appear qualitative, but closer investigation may prove the effect to be only a quantitative one. This finding may prove to be of interest in connection with the properties of latex concentrate and with the coagulation and drying behaviour of sheet and crepe rubber.

Work with the fraction of fresh latex separated by high speed centrifugation has extended our knowledge of this material, which appears to play an important role in controlling latex behaviour upon ammoniation.

We have continued to send regular supplies of freeze-dried latex fractions to our colleagues at B.R.P.R.A. for their investigations of non-rubber constituents.

*Microbiology of latex*—The application of bactericides to rubber trees has led to some interesting observations, which are being actively followed up at present. Earlier work had demonstrated that the tapping cut of a tree in normal tapping is heavily infected with bacteria. It has now been demonstrated that by treatment with powerful bactericides, additional flow of latex from the tree is obtained. The effect is thus one of yield stimulation. The properties of the latex are also improved by virtue of a lower degree of bacterial contamination.

Preliminary observations suggest that on first tapping a rubber tree, a response mechanism develops due either to wounding or possibly to bacterial infection; this appears to modify the properties of latex emerging from the tree and is being studied further.

A method has been developed for counting total bacterial cells in latex, as opposed to viable ones only; this demonstrates that on collection field latex is grossly contaminated and may contain up to  $1 \times 10^{10}$  total cells per ml. Commercial supplies of concentrate contain  $1 \times 10^8$  to  $1 \times 10^9$  total cells per ml. Although these cells are largely non-viable, they are a potential source of enzymic activity which can produce marked changes in latex behaviour.

*Polymer chemistry*—Work with fresh latex has confirmed the greater chemical activity of the rubber hydrocarbon on first emerging from the tree compared with that observed after shipment of latex or dry rubber to consuming countries. Deliberate aeration of latex induces considerable peroxidic activity of the hydrocarbon which can then be directed towards carbon-carbon cross linking and hardening of the rubber or towards molecular chain scission and softening. Peroxidic activity of aerated fresh latices initiates polymerisation reactions and leads to the ready formation of graft polymers, having properties different from those of grafts prepared in consuming countries. The implications of these findings are now being studied.

*Drying of rubber coagulum*—Practical studies to provide basic data on which to design houses for drying rubber are nearly finished but major conclusions will have to await completion of the statistically designed block experiment. One definite interim conclusion is that increasing the relative humidity of the drying air slows down the drying, even during the later stages, when diffusion of water through the rubber is a controlling factor. An increase in relative humidity from 25 to 55% increases the drying time by some 40%. This is contrary to views expressed by previous investigators, which postulated the formation of a dry skin in the presence of low humidity drying air, and a subsequent trapping of moisture within the sheet, thus retarding drying.

*Applied research*—Investigations applying research findings to the solution of practical problems have shown some promising new possibilities described below.

*Reduction of bacterial contamination of latex*—In respect of preparing latex concentrate, a statistically planned experiment has established that control of cleanliness in factory operations results in definitely lower bacterial contamination. Very thorough washing with clean water was surprisingly effective, but in some instances bactericidal washes are preferred.

*Low-ammonia preserved latex*—Early commercial trials with latex of low ammonia content preserved with boric acid have shown this system to be promising, although a few problems still remain to be solved before completely satisfactory concentrate can be prepared. Other new preservative systems are also being studied.

*Processing of preserved latex*—Work on establishing tests for the suitability of latex concentrates for foam rubber production has continued and a first brief survey of commercial Malayan concentrates has been made. It is interesting to record that for satisfactory foam preparation the formulation employed had to be changed for some of the latices, confirming the variability in properties of commercial supplies experienced by manufacturers. No correlation between foam making property and chemical analysis could be demonstrated.

*Reducing variability of dry rubber*—Further experimental work has confirmed earlier observations that certain basic constituents of latex play an important part in controlling vulcanisation behaviour. The present work has indicated a simple means of assaying



these constituents which could possibly be applied to normal estate production with a view to controlling the properties of the rubber produced. These studies form part of a programme investigating a means of preparing dry rubber by a continuous process, with a view to reducing labour charges, at the same time permitting greater technical control leading to a more uniform product.

*Modified dry rubbers*—On the dry rubber side, the cost of preparing superior processing rubbers has been reduced by modifying the vulcanisation system used. The application of SP characteristics to lower grade rubbers has also been studied and a method employing a concentrate or masterbatch worked out. By mixing the required proportion with a lower grade stock, rubbers having excellent SP characteristics can be obtained. Addition of the masterbatch can be made to scrap rubber in remilling operations to produce SP remilled crepe. Alternatively the masterbatch can be shipped to consuming countries and used direct by manufacturers by admixing with normal rubber stocks on the mixing mill or banbury. About half a ton of SP masterbatch has been shipped to the U.K. for laboratory tests by B.R.P.R.A. and for small scale commercial trials.

*Technical developments*—In the field of technical development, the major problem being studied at present is disposal of effluent from latex factories. Serious pollution of water courses has occurred and there is an obvious need for suitable means of disposal to be worked out for Malayan conditions. It is proposed to build an experimental full scale plant for treating effluent at our Experiment Station and to determine optimum conditions for operation.

A preliminary examination of the use of ultra-violet light for killing bacteria in latex has demonstrated that a 90% kill can readily be obtained. Unfortunately the cost of maintaining the plant was found to be high and the project appears to be unpromising unless a cheaper source of u.v. light becomes available.

Work has been carried out on a new speciality rubber developed at B.R.P.R.A. This material retains a rubbery nature at low temperatures, by virtue of its non-crystallising character. Production in the U.K. has involved the use of twice centrifuged latex, owing to certain inhibitors present in latex serum which interfere with the preparational process. Attempts to produce the rubber more cheaply in Malaya have already met with some success and further developments are now being followed up.

Considerable interest has been shown in superior processing (SP) rubber and during 1957 the total production in Malaya for commercial consumption was 339 tons. Interest in cyclised rubber has also been shown and commercial production amounted to 142 tons. The R.R.I. continued to carry out quality control tests on all production lots of these rubbers.

### Advisory Work

Advisory work has increased in volume during the year, our records for correspondence, interviews and visits all showing an increase compared with the previous year.

Many estates have been concerned with replanning old and building new smoke-houses. On sites with high water tables it is now recommended that normal R.R.I. types are built, raising the floor a few feet above ground level and providing ramps to permit entry of trucks. Drying sheds which employ a forced draught and oil firing have become popular, although inclusion of smoking facilities has not yet been fully worked out, and the usual practice is to air dry for the early stages and follow with a final period of drying in a normal smokehouse.

Good colour in pale crepe still presents problems, which are difficult to solve. The R.R.I. bleaching agent, Emulsion A concentrate, continues to be used on a large scale. Recent trials on estates have in some instances demonstrated the value of oxalic acid for preventing discolouration of crepe on storage. Another source of poor colour appears to be the use of totally enclosed systems in oil-fired drying sheds; it is recommended that a small intake of fresh air is permitted, if good colour is required.

The need for persistent attention and care in maintaining scrupulous cleanliness in latex factories has become increasingly apparent. In a number of cases considerable improvement in quality of concentrate has resulted from a study of viable bacterial counts in utensils and plant as well as in the latex itself. In cases where it has been difficult to avoid poor field hygiene, there has been an inclination for producers to increase the use of additives to normal ammoniated latex concentrate, in an attempt to combat bacterial infection. Substances such as Santobrite and formalin have been employed. Such practices are to be avoided where possible, since a large number of dead bacteria in latex concentrate can also have deleterious effects brought about by enzyme activity; every effort to improve field hygiene should be made.

Considerable interest has been shown in low ammonia latex concentrates. Commercial production has been mainly concerned with Santobrite type latices, whilst boric acid and Z.D.C. types, both first developed at R.R.I., have also been shipped in considerable quantities.

The number of estates making use of the R.R.I. testing facilities for Technical Classification was 88 at the close of the year. The amount of rubber classified by estates during 1957 is estimated at 25,629 tons. To this must be added 765 tons from packing houses and a further 1,597 tons, which was produced and classified by the Socfin Company. The estimated total for Malaya in 1957 is thus 27,991 tons. The demand for Malayan T.C. rubber still favours the medium vulcanising class, Yellow Circle.

The R.R.I. has continued to act as technical coordinator for the international aspects of the scheme, under the auspices of the International Rubber Research Board.

#### SMALLHOLDERS' ADVISORY SERVICE

At the end of the year field staff comprised 22 Rubber Instructors, 39 Junior Rubber Instructors and 10 Rubber Demonstrators; 3 Chinese and 2 Malay Rubber Instructors and 4 Junior Rubber Instructors having resigned during the year. One new Rubber Instructor was appointed.

Three scholarships to the College of Agriculture were awarded to boys intending to become Rubber Instructors.

*Planting of rubber*—New planting by smallholders continued at a similar level to 1956 and 11,281 acres were reported. There has been an encouraging increase in the acreage of budgrafted material established with a corresponding reduction in the proportion of clonal seedlings which declined from 87% in 1956 to 72%. This tendency towards the better planting material has been most pronounced in Johore and Kedah. RRIM '600' series clones, although not yet recommended for large-scale planting have been made available to smallholders wishing to use them and 2,430 yards of budwood were sold, mainly in Perak, Kedah and Johore.

A number of replantings commenced in 1952 or 1953 have received the final instalment of the replanting grant and a survey of some of these holdings was undertaken.



Preliminary analysis shows wide variation in the standard of planting with stands generally too dense for optimum growth. Root disease was apparent in nearly half the holdings surveyed but serious damage from disease was remarkably low.

*Processing*—Sales of latex by smallholders have continued at the 1956 rate, about 5,500 tons dry rubber being sold in this way. Efforts to encourage central processing have continued.

*Field investigations*—Poor results having been obtained with oil based herbicides; field trails with 'Dowpon' were laid down on sheet lalang. Twenty pounds 'Dowpon' in 120 gallons water with 6 fluid oz wetting agent per acre proved effective and 29 demonstrations were carried out in cooperation with the Rubber Industry (Replanting) Board. Dowpon used at 20 lb per acre defoliated trees in certain cases but their recovery was rapid and it is considered that such mild toxic effects can be tolerated if lalang is efficiently eradicated.

In a preliminary consideration of the trials of hedge planting, maintaining a proportion of the original stand showed retardation in all cases and any such system is considered impracticable for smallholders.

*Information and Instruction*—A Rubber School to accommodate 22 resident students was established at Ayer Pa'abas, Malacca where 13 acres of old rubber were purchased and buildings in the Menangkabau style erected. Training here started in August and 35 students completed one month courses. A rubber holding maintained only for training purposes is of great assistance to Instructors, and rubber schools will be developed in other parts of the country.

Training courses at the R.R.I. Experiment Station were continued and four courses catering for 136 trainees were completed. Courses conducted by Rubber Instructors at their stations also continued and 88 students completed training.

Rubber Instructors or Junior Rubber Instructors have provided instruction on rubber at courses run by the Department of Agriculture at several centres and have also provided a large number of lectures and demonstrations to groups of smallholders in the kampong.

More advanced training was provided for students from Sarawak, North Borneo and Malaya in conjunction with the training of new Junior Rubber Instructors, and a special short course was provided for 15 Rubber Assistants of the Department of Agriculture.

The Mobile Cinema Unit visited all parts of Malaya during tours totalling 190 days in which 144 film shows were given. The Unit was also used in conjunction with the training courses mentioned above.

Exhibits were provided for Agricultural Shows in Johore, Malacca and Kelantan and a smallholders rubber sheet-making competition was arranged at the MAHA Exhibition in Kuala Lumpur and at the Kota Bahru Agricultural Show.

The following publications were received from the printer and issued to Rubber Instructors for distribution.

|                             |                                   |
|-----------------------------|-----------------------------------|
| Replanting on Smallholdings | (Jawi)                            |
| Good Tapping                | (English, Jawi, Rumi and Chinese) |
| Manuring of Young Rubber    | (Jawi leaflet)                    |
| Budgrafting Poster          | (Rumi, Chinese and Dyak)          |

## R.R.I. EXPERIMENT STATION

| Details of the acreage statement at 31 December were: |               |        | Acres                |
|-------------------------------------------------------|---------------|--------|----------------------|
| Mature area:                                          | In tapping    |        | 1,176.25             |
| Immature area:                                        | New plantings |        | 797.75               |
|                                                       | Replantings   |        | 157.75               |
| Nurseries                                             |               |        | 31.25                |
| Smallholders' seed garden and nurseries:              |               |        |                      |
|                                                       | Mature        | 141.50 |                      |
|                                                       | Immature      | 60.75  | 202.25               |
| Clearings:                                            |               |        |                      |
|                                                       | New plantings | 165.00 |                      |
|                                                       | Replanting    | 41.50  |                      |
|                                                       | Nurseries     | 7.25   | 213.75               |
| Building site and roads                               |               |        | 89.50                |
| Reserve land                                          |               |        | 310.50               |
|                                                       |               |        | <hr/> 2,979.00 <hr/> |

*New Planting and Replanting*

*New planting*—An area of 165 acres of secondary jungle was felled, cleared and planted. The area was divided into two blocks, one of 66 acres which was contour terraced and lined 30 x 8ft and the other of 99 acres which was straight planted and lined 24 x 8ft over 53 acres and 24 x 10ft over 40 acres. A steep ravine of 6 acres within the second block was contour terraced and lined 24 x 10ft.

Steep areas in the straight planted section were platformed and 850 chains of contour silt pits were cut for prevention of soil erosion. This area is allocated for Soils Division experiments.

A further section of 30 acres of the clearing was planted with the 1955 and 1957 hand pollinated seedling stumps and basket plants, 53 acres were planted with Tjir 1 clonal seedling basket plants and the remainder of the area was planted with seedling stumps as stocks for budgrafting in 1958. These areas are allocated to the Botanical Division.

Leguminous creeping covers were sown throughout the area and selected indigenous plants were allowed to regenerate between planting rows.

Extensive draining in ravine areas was done, a total of 281 chains of drains of various sizes were cut.

New roads totalling 119 chains were constructed through the clearing and the perimeter was fenced.

*Replanting*

Field 6 (the original manuring experimental area planted in 1928) and 6A nursery (44 acres) were felled and stumps poisoned. 41.5 acres were replanted with clonal seedlings in baskets. 2.5 acres were clean cleared, levelled and reserved as a football ground.

Leguminous creeping and bush covers were sown throughout with the exception of the cover crop trial area.



## Report of the Director

Nurseries: Eight acres of old rubber in Field 15 were felled by uprooting and the area clean cleared. Five acres were lined 2 x 2 and planted with selected seedlings. The remaining 3 acres was planted with creeping legumes.

### Immature Areas

*Budgrafting*—Field 60D (20 acres): 16 different clones were budded in 31 discard plots within the '1954 Exchange' clones trial. Other clones were budded on the boundary between the *Dothidella* resistant and Foreign Exchange clones trials. In the remaining discard areas clone PR 107 was budded.

Field 60G (15 acres): Clone PR 107 was budded in the areas surrounding Field 60E.

Field 60F (25 acres): The main panel clones (PB 86, RRIM 501, Tjir 1) in this top budding experiment were budded and nine *Dothidella* resistant clones selected as crowns were budded in observation plots.

Field 60H (46 acres): A small scale trial from the 1955 H.P. seedlings was budded. Boundaries and discard plots were budded with PR 107.

Field 24/R (32.5 acres): The main plots within the trial area were budded with GT 1, 3 discard plots were budded with PB 86 whilst the remainder of the field was budded with PR 107.

Field 23/R (7.5 acres): Soils Division Cover Crop Experiment: This area was budded with RRIM 603.

*Manuring*—Fertilisers were applied in the following fields:

| Field                 | Acres | Rate per tree    | Fertiliser               |
|-----------------------|-------|------------------|--------------------------|
| Fld 16N (H.P.S.trial) | 6.5   | 1 lb + 1½ lb     | Mixture X                |
| 16N (balance)         | 4.5   | 12 oz (3 applns) | " X                      |
| 23                    | 61.5  | 4 " (" " )       | " X                      |
| 24                    | 32.0  | 4 " (" " )       | " M                      |
| 37                    | 5.0   | 14 "             | " X                      |
| 47                    | 40.0  | 3 lb             | Sulphate of ammonia      |
| 51                    | 63.0  | 2½ "             | Mixture D                |
| 54 (discard)          | 32.0  | 1 " (2 applns)   | Special Mixture          |
| 57                    | 40.0  | 1 "              | Mixture D                |
| 58                    | 74.0  | 14 oz            | " D                      |
| 60A                   | 10.8  | 8 "              | " D                      |
| 60B                   | 14.0  | 8 "              | " M                      |
| 60C                   | 26.5  | 4 "              | " D                      |
| 60D                   | 120.0 | 8 "              | " M                      |
| 60F                   | 25.0  | 4 "              | " D                      |
| 60G                   | 15.0  | 4 "              | { " D(flat)<br>" M(hill) |
| 60H                   | 46.0  | 4 "              | " D                      |
| 61                    | 84.0  | 8 "              | " M                      |
| S.H.N.                | 166.0 | 4 lb             | " Mag.Y                  |

*Thinning out* — Fields 51C & D (30.7 acres) : Reduced from 217 to 144 trees per acre.

*Field 51* (5 acres): Demonstration plots of clone PR 107 thinned to 144 trees per acre.

*Fields 52B, El* (36.5 acres): Stand thinned in the non-R.R.I. clone trial and demonstration plots of non-R.R.I. clones to 158 trees per acre,

*Field 52C* (2.1 acres): The two plots of LCB 1320 and RRIM 520 were thinned from 217 to 144 trees per acre.

*Field 55A* (37 acres): Reduced from 180 to 150 in the trial of clones from the imported seedling collection (seedlings obtained from Brazil and Panama).

*Fields 56A & Field 52E II* (19.3 acres): The stand of the small scale trial from the 1951 H.P. seedlings was thinned from 180 to 150 trees per acre.

#### *Pests and Disease*

*Root disease*—All immature areas came under regular inspection for root disease. Details are as follows:

| Area collar inspected . . .    | New planting<br>772 acres |                | Replanting<br>190.5 acres |                |
|--------------------------------|---------------------------|----------------|---------------------------|----------------|
|                                | <i>Treated</i>            | <i>Removed</i> | <i>Treated</i>            | <i>Removed</i> |
| <i>Cases:</i>                  |                           |                |                           |                |
| <i>Fomes lignosus</i>          | 299                       | 372            | 25                        | 41             |
| <i>Ganoderma pseudoferreum</i> | 21                        | 85             | 34                        | 17             |
| <i>Fomes noxius</i>            | 15                        | 28             | —                         | 4              |
| <i>Ustulina zonata</i>         | 8                         | 1              | 9                         | 6              |
| <i>Poria</i>                   | 4                         | 1              | 4                         | 2              |
|                                | <u>347</u>                | <u>487</u>     | <u>72</u>                 | <u>70</u>      |

*Pink disease*—Considerable attention was given to keeping pink disease under control in the older immature areas during the wet months. The presence of RRI 501 as a “control” clone in many areas entails constant vigilance in control of ‘Pink’. A total of 13,194 cases were treated with Bordeaux mixture. Four hundred and eighteen acres were under regular inspection.

*Termites*—A prophylactic application of 1 pint of Aldrex 1:400 was completed in Fields 51, 52, 53, 54, 55 & 61. Total acreage treated was 418.25 acres. Over the rest of the immature area monthly inspection and treatment was carried out.

*Storm damage*—Three hundred and five cases of storm damage were treated. Eighty-five trees being removed and the remainder pruned or pollarded.

*General maintenance*—Regular weeding rounds and lalang patrols were maintained throughout the immature area. Five hundred and ninety eight acres were under quarterly strip spraying with sodium arsenite at the end of the year, whilst the remainder of the area was under periodic manual weeding of planting rows with, in some cases, selective weeding between rows. Drains were upkept quarterly and areas under natural covers were slashed every three to four months.

#### *Mature Areas*

The system of maintenance and upkeep remained unchanged.

## Report of the Director

**Manuring**—The following fields were given an application of fertilisers:

| Fields      | Acres | lb | Mixture |
|-------------|-------|----|---------|
| 43 & 17 C/R | 13    | 4  | A       |
| 48          | 149   | 4  | B       |

### **Pests and Disease**

**Root disease**—Collar inspection and treatment was carried out in known diseased areas in the young mature areas. Details are as follows:

|                   | Acres  | Total cases | Treated | Removed |
|-------------------|--------|-------------|---------|---------|
| Collar inspection | 202.25 | 50          | 31      | 19      |

**Pink disease**—202.25 acres were inspected and 2,909 cases were treated with Fylomac 90.

**Termites**—There were 782 reported cases of which 762 were treated and 20 removed.

**Storm Damage**—1207 cases were treated and branches pruned while 532 trees were removed.

### **Pruning and Thinning Out**

**Field 45A (40 acres)**: The stand in the RRI 600 series large scale trial, Prang Besar observation plots and Glen 1 areas was reduced from 140 to 125 trees per acre.

**Field 45D (17.2 acres)**: The RRI 600 series clones (second selection) was thinned from 144 to 130 trees per acre.

### **Tapping**

203.25 acres of young rubber, composed of the areas detailed below, were brought into bearing during the year:

| Field      | Acres |                                                           |
|------------|-------|-----------------------------------------------------------|
| 52A        | 8.5   | Trial of the 1949 hand pollination seedlings and controls |
| 48B, C & E | 10.5  | Clone Gl 1 in discard areas                               |
| 49         | 53.25 | Small-scale clone trials                                  |
| S.H.N.     | 131   | Seed gardens A, B, D(I) and D(II)                         |

An area of 146.75 acres of old rubber scheduled for replanting between 1957 and 1959 was under intensive tapping for most of the year.

Yield stimulants were applied over a further 61.5 acres where panels were turned over to virgin bark about 10 inches above renewing bark.

### **Crop and manufacture**

A total crop of 1,188,146 lb of rubber was harvested, giving an average of 902 lb per acre overall.

The following grades of rubber were processed:

| Manufactured:                  | lb      |
|--------------------------------|---------|
| RSS                            | 1,979   |
| SP sheet (Superior Processing) | 366,973 |
| Skim sheet                     | 10,510  |
| Crepe milling grades           | 255,121 |
| SP crepe                       | 528     |
| Skim crepe                     | 34,426  |
| Latex concentrate              | 415,791 |



|                        |                       |
|------------------------|-----------------------|
| <i>Unmanufactured:</i> | <i>lb</i>             |
| Latex — d.r.c.         | 1,775                 |
| Scrap                  | 44,825                |
| Cup samples            | 56,218                |
|                        | <hr/> 1,188,146 <hr/> |

### *Experimental*

Further details of work under this heading are contained in the reports of the Divisions concerned.

*Recording* (Botanical & Soils Divisions)—Yield recording in experimental areas continued by the cup coagulation system. Labelling of trees, collection and weighing of samples was done monthly. Girth, height and bark measurements were recorded in many experimental areas.

*Manurial trials* (Soils Division)—Fertilisers were applied in the experiments in Fields 15, 47, 31, 54, 60 and S.H.N. Two new trials were started in Garden B of the S.H.N.

*Spraying trials* (Soils Division)—Numerous spraying trials were carried out to test out various herbicides on lalang, grass, ferns, leguminous covers and shrubs.

*Cover crop trials* (Soils and Botanical Divisions)—Trials of various cover crops in Fields 23 and 24 replantings received application of fertilisers.

*Tapping and yield stimulant experiments* (Botanical Division)—A new intensive tapping experiment on medium aged buddings in Field 33 was started.

One new yield stimulant experiment in Field 25(5) was started. The experiment in Field 46 was discontinued.

*Hand pollination* (Botanical Division)—8,890 pollinations were made between selected clones and 448 fruits were harvested.

### *Seed Gardens and Budwood Nurseries*

A total of 15,343 yards of budwood of various clones was distributed to estates for commercial or experimental planting.

The budwood nursery interplanted between the avenues forming the seed gardens in the Smallholders' Nursery Reserve was reduced from 24 acres to 7 acres — 43,714 yards of budwood were despatched to smallholders and 38,800 seed were harvested from Gardens A and B. Normal upkeep was maintained throughout this area of 190 acres and avenues in all gardens received an application of 4 lb per tree of Mixture Magnesium Y.

### *General*

*Buildings*—One pair of semidetached Junior staff quarters and one pair of semi-detached Artisans' quarters were constructed during the year. The manager's bungalow, ten junior staff quarters and the bachelors' quarters were renovated and painted. Complete renovation of the Pathological Division store, partitioning off part as an office, and repairs to the packing shed were completed.

*Machinery and electricity supply*—The creping battery received a major overhaul including regrooving of 1 set of rollers and replacement of worn gears. The Central Electricity Board continued to serve the Station; the Experiment Station generators provided electricity on the few occasions when breakdowns occurred.

## Report of the Director

**Water supply**—31½ chains of 4 inch asbestos cement piping were laid to replace the fouled water pipe lines.

**Training courses** (Smallholders' Advisory Service and R.R.I.E.S. staff)—Two courses of a week's duration were held for estate senior conductors by Experiment Station Staff. A Junior Rubber Instructors' course attended by 32 candidates was held from 10 August to 19 October, 1957.

**Training courses for Smallholders**—144 kampong youths attended 4 courses each of a month's duration.

**Visitors**—There were 407 visitors to the Station during the year including a steadily increasing number of foreign visitors.

**Labour force**—There were no revisions in wage rates during the year. The labour force was contented and there was a plentiful supply of labour throughout the year.

Labour strength at 31 December, 1957 was:

| <i>On check roll</i> | <i>Men</i> | <i>Women</i> | <i>Children</i> | <i>Total</i> |
|----------------------|------------|--------------|-----------------|--------------|
| Indians              | 210        | 174          | 26              | 410          |
| Malays               | 4          | —            | —               | 4            |
| Total on check roll  | 214        | 174          | 26              | 414          |
| <i>On contract</i>   |            |              |                 |              |
| Malays               | 24         | 6            | —               | 30           |
| Chinese              | —          | 3            | —               | 3            |
| Total workers        | 238        | 183          | 26              | 447          |
| Dependants (Indians) | 5          | 16           | 342             | 363          |

**Health**—The health of the resident population, in general, remained satisfactory. In April/June there was an epidemic of influenza during which flies became a nuisance and have persisted throughout the year. All measures to control this nuisance, even with the help of the I.M.R., have failed.

There were:           32 births  
                          3 deaths  
                          74 cases admitted to hospital  
                          1,932 minor cases treated locally.

**Emergency**—The Station continued to be situated in a food restriction area up to September; thereafter certain restrictions were removed and the Station became a 'Grey Area'.

**Staff**—Mr R. F. Harley, Manager of the Station, proceeded on long leave on 1 November. Three members of the junior staff took long leave during the year.

This brief Report is compiled by the Director from reports and notes submitted by the Heads of Divisions and Sections and by the Acting Manager of the R.R.I. Experiment Station.

C. E. T. MANN  
Director

## Soils Division

The Head of Division, the Soils Chemist (Dr G. A. Watson) and Assistant Soils Chemist (Mr M. M. Guha) were on duty throughout the year. The Plant Physiologist (Dr E. W. Bolle-Jones) resigned and left the service of the Institute in August. The vacancy was filled by the appointment of Dr V. M. Shorrocks who reported for duty on 28 August. Mr V. R. Mallikarjuneswara (Assistant Chemist, Nutrition Section) resigned and returned to India in April. He was replaced by Mr K. Raman who assumed duty on 23 April.

At the end of the year the staff of the Division consisted of 3 Senior Officers, 2 Graduate Assistants, 1 Laboratory Superintendent, 20 Laboratory Assistants, 8 Field Assistants, 1 Typist, 1 Clerk and 5 Laboratory Attendants.

The following papers by members of the Soils Division Staff were published during the year.

1. In the *Journal of the Rubber Research Institute of Malaya*:

Cover Plants in Rubber Cultivation.

Manuring Hevea: Effect of Fertilisers on Growth and Yield of Mature Rubber (in collaboration with D. R. Westgarth and C. G. Iyer of the Statistics Department).

A Magnesium-Manganese Interrelationship in the Mineral Nutrition of *Hevea brasiliensis*.

Susceptibility of Hevea Seedlings to *Helminthosporium hevea* Attack in Relation to their Nutrient Status, (in collaboration with R. N. Hilton of the Pathological Division)

Flame Photometric Determination of Potassium and Calcium and the Chemical Estimation of Phosphorus, Magnesium and Manganese in Leaves of Hevea.

Effects of Mineral Status and Light on Rubber Formation in Hevea.

2. In *Nature*:

A Beneficial Effect of Cobalt on the Growth of the Rubber Plant *Hevea brasiliensis*.

Rubber Formation in *Hevea brasiliensis* as Affected by Light and Mineral Status.

3. In *Plant and Soil*:

Copper: Effects on the Growth and Composition of the Rubber Plant *Hevea brasiliensis*.

Short papers on the following subjects were published in the *Planters' Bulletin*: Dowpon—alang and grass eradicator; Effect of manuring on growth and yield; Magnesium deficiency; Trial of the Holt weed breaker.

Facilities were made available for Miss Widowati Rusmiputro from Indonesia, holder of a Fellowship awarded by the Food and Agriculture Organisation of the United Nations, to work in the nutrition section of the Soils Division as a visiting worker for training under the guidance of Dr E. W. Bolle-Jones. Miss Rusmiputro



arrived in December 1956 and left in August 1957. She was given facilities to learn the pot-sand-culture techniques and was associated with work carried out during the year to study the effects of nutrient deficiencies on *Centrosema pubescens*.

Dr Georg Hauser, Soil Expert F.A.O. in Indonesia, visited the Institute in April for consultations with Officers of the Soils Division and with Miss Rusmiputro.

Visits to estates by Research Officers included 61 advisory visits and 56 visits in connection with field experiments most of which inevitably involved some advisory work. The advisory visits were made largely to investigate the cause of backward growth or other abnormalities, to advise on manuring and to examine areas with a view to assessing their suitability for planting or replanting.

The Soils Chemist (Dr G. A. Watson) gave two talks on soil topics to Senior Estate Conductors and one talk to Smallholders' Rubber Instructor Trainees attending courses of instruction at the R.R.I. Experiment Station. He also gave a lecture to members of the South Johore Branch of the Incorporated Society of Planters at Johore Bahru and the Head of Division gave a lecture to the Central Selangor Branch at Kuala Lumpur.

The usual assistance was given to the Technical Education Scheme of the Incorporated Society of Planters by setting questions and marking papers for the soils section of the Agricultural Science Examinations held in February and August.

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## RESEARCH

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### MANURING OF HEVEA

*Effect of fertilisers on growth*—Growth measurements recorded in 42 experiments in rubber areas of different ages were examined and the results generally confirm earlier conclusions as reported in the *Annual Reports* 1953 to 1956. The general pattern of effect of fertilisers on growth is fairly consistently uniform in areas on inland soil types; a response of varying magnitude to applications of nitrogen and phosphorus can be expected in most areas and at all stages of growth, while responses to applications of potassium and/or magnesium may be obtained in some areas depending upon soil type and probably upon previous history of cultivation.

Results obtained during the year confirm that an application of phosphate in the planting hole at time of planting has a marked beneficial effect on growth of rubber both in replantings and new plantings on inland soil types. In regard to fertiliser treatment after planting, the main effect in the first and second year is due to nitrogen, an effect which increases with increasing frequency of application. The evidence suggests that, during this period, there may be no response to additions of phosphate over and above that applied in the planting hole just before planting. But in the third year after planting the effect of further additions of phosphate becomes apparent and continues during the remaining years of immaturity. At the same time, growth is accelerated also by further applications of nitrogen; in one experiment on a light sandy soil a very marked beneficial effect due to nitrogen was detectable throughout the period of immaturity. Mean girth of budgrafts at 50 inches above ground 8 years after planting was 2 inches greater in plots which received regular applications of nitrogen than in those which were not treated with nitrogen. A positive response to potash was established in 3 out of 9 experiments in progress in immature areas.

Records of annual girth increments in 33 experiments in mature rubber areas were examined individually. A beneficial response to fertiliser treatment was established with confidence in 22 experiments and there were indications of a response (significant at the 10% level) in 5 others. The effect was due mainly to nitrogen (14 experiments) or phosphorus (13 experiments). A response to both nitrogen and phosphorus was established in 5 experiments. A positive response to potassium, in terms of growth, was established in 3 experiments and there were indications of a beneficial effect in 2 other areas. No important interaction effects were detected.

In experiments where treatments with superphosphate and rock phosphate are compared, results continue to show that the soluble and insoluble phosphate fertilisers are equally effective judged in terms of their effect on growth of rubber. This is not surprising since the soils in all areas are acid with pH values falling in the range 4.5 to 5.5. No consistent difference was observed between the effects of broadcast and 'pocket' methods of application of either superphosphate or rock phosphate.

*Effect of fertilisers on yield*—Annual yield records from 34 manuring experiments were analysed during the year. A positive response to manuring was established with confidence in 10 experiments and there were indications of a beneficial effect in 6 other experiments. The effects observed in these 16 experiments were due to nitrogen (4 areas), phosphate (8) and potash (3) with a positive N x K interaction in one experiment. In one area on alluvial clay soil results showed a negative response to potassium and a negative N x P interaction effect.

In experiments where fertiliser treatments include applications at different levels, the results examined show that the effect of nitrogen was predominantly linear. Sulphate of ammonia was applied at different levels in the range 0 to 6 lb per tree in alternate years and in areas where yield response to treatment was established the magnitude of the effect usually increased with increasing levels of application. The pattern of effect due to treatment with phosphate, however, was rather different. Levels of application tested in 9 experiments were in the range 0 to 4.8 lb superphosphate or rock phosphate per tree in alternate years. A linear effect was established in only one area while in all others the measured response in terms of yield did not increase with increasing rates of application beyond the first level. The evidence suggests that the optimum level of application of phosphate for mature rubber areas is about 1.5 lb per tree biennially or 0.75 lb per tree annually.

No difference was observed between yield effects due to treatments with superphosphate and rock phosphate nor between broadcast and 'pocket' methods of application of the phosphates.

The magnitude of the effect due to treatment with fertilisers, measured in terms of yields in individual experiments, varied between 10 and 30 per cent. The maximum effect was recorded in the experiment at the RRI Experiment Station where yield recording has been done with more precision than is possible on the average estate and the data obtained are judged to be more accurate in this than in the other experiments under consideration. In this area at the RRI Experiment Station fertilisers have been applied every second year since 1947. The magnitude of the effect due to fertiliser treatment has increased steadily in recent years and amounted to 29.8 per cent in the NPK plots (best treatment) in 1957.

#### CULTIVATION AND GROUND COVER

*Weed eradication*—Spraying trials on lalang were continued. Consistently good results were obtained by spraying with Dowpon (the sodium salt of 2,2-dichloropropionic acid) at the rates of 15 and 20 lb per acre. The results with applications at

the rate of 10 lb per acre, although generally good, were less consistent and were more dependent on weather conditions at the time of spraying and on the skill of the workers. For control of lalang on a large scale the recommendation, based on the results of several trials, is to spray with a 1½% solution of Dowpon at the rate of 100 gallons per acre. New growth begins to appear at about 3 months after spraying but regeneration is slow and can easily be dealt with by wiping with oil.

Aminotriazole applied at the rates of 5, 15 and 45 lb per acre was found to be comparatively ineffective. It caused severe chlorosis, which increased steadily with time and lasted for several months, but the lalang was not killed.

Further field trials were carried out to test a variety of new herbicides for control of the smaller grasses, mainly *Axonopus compressus* and *Paspalum conjugatum*, which occur most commonly in rubber areas. Best results were obtained with Dowpon at the rate of 10 lb per acre and Aminotriazole at the rate of 15 lb per acre. Lower applications of the latter (5 and 10 lb per acre) were appreciably less effective. A follow up treatment with Neburon (1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl urea) at the rate of 2 lb per acre two weeks later had no noticeable effect on the rate of recovery either in the plots sprayed with Dowpon or in those sprayed with Aminotriazole. The treatment with Neburon was tested following a suggestion that urea herbicides may be used to better effect for preventing re-establishment of vegetation from seed rather than for knocking out established vegetation.

*Paspalum conjugatum* is more resistant to Dowpon than is *Axonopus compressus*. This may account for disappointing results with Dowpon reported by some estates. Aminotriazole, on the other hand, is more effective on *Paspalum conjugatum* than on *Axonopus compressus*.

Small scale trials are in progress to examine the possibility of using Dowpon and/or Aminotriazole as a substitute for sodium arsenite for routine control of grasses along planting rows (strip spraying). First results with Dowpon were disappointing and it was noted that *Paspalum conjugatum* was the dominant grass in the trial area. Preliminary results from a further trial in the same area show that Aminotriazole or a mixture of Aminotriazole and Dowpon may be more effective.

Observations made in the strip spraying trials indicate that closer attention must be given to the volume as well as concentration of the Dowpon solution applied per unit area than is the case when using a solution of sodium arsenite or sodium chlorate. The conclusions arrived at are that the volume of solution applied should not be less than three quarters of a gallon per chain length of strip and that the amount of Dowpon applied should not be less than 10 lb per acre of sprayed area.

Other new herbicides tested for control of the smaller grasses were ACP-M-406 at the rates of 5, 10, 15 and 20 lb per acre with and without the addition of LFN-M-389, a surface active agent, but none of the treatments was effective.

Neither Dowpon nor Aminotriazole is sufficiently selective for control of grasses growing amidst legumes. Although they appeared at first to be more effective in killing grasses, the legume creepers died later. The tall sedge *Scleria multifoliata* is resistant to the weedkillers most commonly used on estates such as sodium arsenite, sodium chlorate and sodium trichloroacetate. Results obtained in small scale trials show that it can be killed by spraying with a 2% aqueous solution (20 lb in 100 gallons per acre) of either Dowpon or Aminotriazole. Less concentrated solutions have not yet been tested. The maximum effect of Dowpon (about 90% kill) was observed at about 6 weeks after spraying while the effect of Aminotriazole develops more slowly and may take up to 5 months before the sedge dies out completely. New growth amounted to not more than 10% of the original stand at one year after spraying.



CMU (3-(p-chlorophenyl)-1:1-dimethyl urea) applied at the rate of 10 lb per acre was appreciably less effective with a kill of not more than about 30%, while Maleic Hydrazide applied at the rate of 20 lb per acre was completely ineffective.

Bracken (*Gleichenia linearis*) was effectively killed by spraying with Dowpon and with Aminotriazole, both at the rate of 20 lb in 100 gallons per acre. As with the sedge, the effect of Dowpon developed more rapidly than that of Aminotriazole but in both cases the bracken was completely killed. New growth at 12 months after spraying amounted to about 5% in the plots sprayed with Dowpon and about 1% after spraying with Aminotriazole. CMU caused severe scorching of the bracken but recovery was noticeable after 10 weeks and was almost complete one year after spraying. Maleic hydrazide was completely ineffective.

Bertam palm or Bertam attap (*Eugeissona tristis* Griff.), commonly found in jungle clearings, is difficult to eradicate in the normal way by slashing. It has been found that the palm can be killed by spraying with sodium trichloroacetate (Lalicide) at the rate of 8 ounces in 2 pints of water per clump. Dowpon at the rate of 4 ounces in 2 pints of water was only slightly less effective while Aminotriazole and CMU, in solutions of similar concentrations, were comparatively ineffective.

Several small scale trials were carried out the purpose of which was to find out if the ubiquitous weed *Mikania scandens*, growing amidst an established cover of legumes, can be selectively eliminated. The herbicides tested were Tropotox or Legumex M (sodium salt of 4-chloro-2-methylphenoxybutyric acid), Legumex D (sodium salt of 2,4-dichlorophenoxybutyric acid), Dynotox (the alkanolamine salt of di-nitro-secondary-butylphenol), Neburon (1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl urea) and Fernoxone (sodium salt of 2,4-dichlorophenoxyacetic acid).

Promising results were obtained in the early trials with three of these herbicides, namely Tropotox, Legumex D and Fernoxone, and further trials were carried out to study the effects of these in solutions of different concentrations. Tropotox and Legumex D (liquid formulations) were applied at the rate of 2, 4 and 6 litres, and Fernoxone at the rates of 1, 2 and 3 lb, in 100 gallons of water per acre. All were more or less effective in suppressing the growth of *Mikania scandens* but a more complete kill was obtained with Legumex D and Fernoxone than with Tropotox. The rate of recovery and re-colonisation by *Mikania* was rather more rapid in pots sprayed with Tropotox than in the other plots.

All the legumes under observation were affected to a greater or less extent by all three herbicides. *Centrosema pubescens* and *Flemingia congesta* are more resistant than the others and suffered only a slight set-back. The leaves of *Pueraria javanica* and *Calopogonium muconoides* were completely scorched and dropped off, but the plants were not killed provided the concentration of the solution was not too high. New leaves began to emerge at about one month after spraying and recovery thereafter was fairly rapid.

Judged on the results in small scale trials Legumex D at the rate of 2 litres, and Fernoxone at the rate of 1 lb, in 100 gallons per acre are the most suitable, the former being slightly better in that its effect on the legumes is rather less severe. Results are encouraging and it would appear that the problem of preventing volunteer growth of *Mikania scandens* from swamping out a cover of leguminous creepers may be solved without resort to the costly method of hand weeding. Further trials with Fernoxone on a larger scale are in progress.

**Ground covers**—Four experiments (factorial 2 x 2 x 2 NPK) designed to compare direct manuring of the rubber with indirect manuring via the ground cover of leguminous creepers have been laid down in young replanted areas. Three other experi-

ments involving comparisons of four different types of ground cover — mixed leguminous creepers, *Mikania scandens*, mixed grasses (mainly *Axonopus compressus* and *Paspalum conjugatum*) and a mixed cover of the better types of indigenous growths — have been started. The effect of these different covers on the soil and on growth of rubber will be studied.

Another experiment in which grasses, *Mikania scandens* and leguminous creepers have been established in different plots is in progress. Statistical analysis of height measurements recorded at twelve months after planting showed no differences due to the various treatments.

In trials comparing methods of controlling the creeping leguminous cover the advantage of strip weeding over circle weeding was measurable at 6 months after planting and increased steadily up to 12 months when the plants were budded. The difference in favour of strip weeding continued in the second year, judged on height measurements of the budgrafts recorded at 9 months after budding. In another experiment where strip weeding was commenced when the trees (clonal seedlings) were 2 years old a similar difference in growth between strip weeded and circle weeded plots was not established, judged on girth measurements recorded at 6, 12 and 18 months after the treatments were applied. Prior to this all plots in this area had been circle weeded.

The inference to be drawn from the results of these two experiments is that strip weeding along planting rows is a better method of upkeep than circle weeding for the first two years after planting, after which time control by circle weeding could be adopted without seriously retarding the rate of growth of the rubber.

*Nutrition of leguminous ground cover*—Further investigations were carried out by means of pot experiments, to study the effects of applications of lime, molybdenum and sulphur on growth and mineral status of *Centrosema pubescens* in a soil suspected of being deficient in molybdenum. Application of lime at the rate of 3 tons per acre increased the dry weights of shoots and roots but decreased the weight of nodules. This treatment also resulted in increasing the nitrogen and molybdenum contents of shoots, roots and nodules; the molybdenum content of all parts was increased by lime both in the presence and absence of applied sodium molybdate.

Application of sodium molybdate at the rate of 1 lb per acre increased the dry weight of shoots and roots, increased the nitrogen content of the shoots and markedly increased the molybdenum content of shoots, roots and nodules.

Application of sodium sulphate at the rate of 20 lb per acre increased the dry weight of shoots but no other effects were noted.

A similar experiment to study the effect of applications of lime and molybdenum on growth of *Pueraria phasecoloides*, using four different soil types, is in progress.

*Effect of gibberellin on legume covers*—Preliminary observations in pot experiments designed to study the effect of gibberellic acid on growth of the three leguminous creepers indicated that *Centrosema pubescens* was the only one to show the stem elongation reported to be the effect observed in other crops. No effect was observed on *Calopogonium muconoides* or on *Pueraria phasecoloides* and no major effects were apparent in small scale field trials with a mixed cover of the three leguminous creepers.

## SOIL INVESTIGATIONS

**Nitrification studies**—The effect of temperature on mineralisation of nitrogen in soils was studied. Soil samples were incubated at 51°C, 32°C and 26°C, these temperatures being of the same order as those recorded on sunny days at the surface of soil (a) uncovered, (b) under a thin cover and (c) under a dense cover of leguminous creepers respectively. Results show that nitrification was completely inhibited at a temperature of 51°C and was slightly higher at 32°C than at 26°C. Rate of ammonification was much higher at the highest temperature than at the two lower temperatures.

As part of the programme to study the mineralisation of soil nitrogen under field conditions, preliminary investigations were carried out to study the changes in the nitrogen status which may occur on storage of samples in the laboratory after collection in the field. It was found that the ammonium-nitrogen content of soil samples does not change appreciably within 24 hours of collection in the field, particularly if stored in a refrigerator but it rises after air drying and increases considerably with oven drying. The nitrate-nitrogen content does not change appreciably when samples are air dried in the usual way.

Evidence has been obtained to show that there is marked increase in nitrification in the soil after the land has been cleared of jungle and planted with rubber. Levels of up to 100 p.p.m. nitrate-nitrogen were found in the topsoil of a jungle clearing compared with levels below 10 p.p.m. in jungle covered soils nearby.

The nitrogen status of soil under covers of *Pueraria phaseoloides*, *Mikania scandens* and grasses is being studied. Preliminary results show a higher level of ammonium-nitrogen than of nitrate-nitrogen at all depths down to 3 feet below the surface under each cover. At the sampling site on a coastal alluvial clay soil the content of nitrate-nitrogen was markedly higher under *Pueraria phaseoloides* than under the other two covers.

## PLANT INVESTIGATIONS

**Methods and techniques**—Time was devoted to developing or modifying methods of analysis with a view to increasing the accuracy and output of analytical results. With the introduction of flame photometric methods for estimating potassium and calcium it has been possible to organise the routine analysis of leaf samples to allow for a 50% increase in output of analytical work.

Further work was done during the year to determine how analysis of bark samples compares with analysis of leaf samples for the purpose of diagnosis of the mineral status of mature rubber trees. The conclusion reached is that bark analysis offers a means almost as satisfactory as leaf analysis for detecting responses to fertilisers containing phosphorus and potassium, but leaves are more suitable material for analysis in routine advisory work involving diagnosis of nutritional disorder. Work is in progress to examine the possibility of assessing fertiliser requirements with more precision on the basis of results of analysis of both leaf and latex samples.

## POT-SAND-CULTURE EXPERIMENTS

**Nutrient deficiency symptoms in legumes used as ground cover**—Experiments were carried out to produce and identify symptoms of nutrient deficiency shown by *Centrosema pubescens* and to study the effects of deficiency levels of each nutrient element on growth and chemical composition of the plant.



Symptoms of nitrogen, manganese, boron and zinc deficiency were produced within a few days after sowing; symptoms of deficiency of the other nutrient elements developed later and were recorded. Deficiencies of boron and zinc markedly reduced growth at an early stage. Nitrogen and calcium deficiency caused severe growth retardation later, while the effects of deficiencies of other nutrients on plant dry weight took much longer to develop and were relatively less marked.

Roots, stems and laminae were analysed separately and the results which have been recorded provide a useful guidance in the interpretation of results of analysis of field samples obtained in the course of advisory work.

*Effects of mineral status and light on rubber formation*—An experiment was carried out in which the effects of mineral nutrient elements and of light intensity on the production of rubber were examined. The results showed that the rubber content of young hevea seedlings, whether growing in light or in darkness, is closely correlated with their dry weight, carbohydrate and protein contents. Light intensity exerts a greater effect on these values than does nutrient status and variation in the latter is of lesser importance as a factor in the formation of rubber.

The effect of mineral status of the plant on rubber formation is an indirect effect determined by the formation of either carbohydrates, proteins or plant dry matter. Any nutritional deficiency which causes a reduction in the formation of carbohydrates, proteins or dry matter also results in a diminution of the amount of rubber formed per plant. Evidence was obtained confirming that micronutrient elements have an important effect. The interpretation of results is made easier if rubber is regarded as a by-product of growth rather than as a food reserve.

*Mineral nutrition in relation to diseases of the rubber tree*—Further observations made in an experiment designed to study the effect of varying levels of nitrogen and calcium on the severity of attack by *Helminthosporium heveae* confirmed that the incidence of the disease increased with increasing levels of nitrogen supply to the plants. Variation in the level of calcium supply produced no significant effect as measured in terms of lesion count. Increased nitrogen supply level increased the nitrogen concentration but decreased the concentrations of phosphorus and potassium in the laminae. It is possible that increased susceptibility to infection by *Helminthosporium heveae* at higher nitrogen levels may be associated with the relative reduction in the concentration of phosphorus and/or potassium in the leaves. This is a point that needs further investigation using different levels of supply of these nutrients.

*Effects of molybdenum on growth and composition of hevea*—Preliminary results of an experiment designed to study the effect of molybdenum deficiency on growth and chemical composition of rubber seedlings under conditions of all nitrate-nitrogen or part ammonium-, part nitrate-nitrogen supply were reported briefly in the 1955 *Annual Report*. Owing to complications arising from iron deficiency effects which developed in the nitrate fed plants, this first experiment was abandoned and a second attempt was made to produce molybdenum deficiency symptoms in a similarly designed experiment. A third experiment was started later in which rubber seedlings were grown in sand and given varying supply levels of molybdenum, sulphate and calcium.

The results confirm the earlier conclusion that if nitrogen was partially supplied in the ammonium form the apparent requirement for molybdenum was less and symptoms of molybdenum deficiency could not be readily produced. Molybdenum deficient seedlings which were not supplied with ammonium ions were smaller and paler than those given molybdenum, and symptoms of deficiency, manifested by tip and marginal scorch in the midstem and upper laminae, developed.

The results of the investigation clearly indicate that a deficiency of molybdenum will cause reduction in height, girth and dry weight of the rubber plant. This effect may be accompanied by the visual symptoms described, which appear more readily in plants receiving nitrogen in the form of nitrates than in those fed with nitrogen in the ammonium form.

The occurrence of marginal leaf scorch was correlated with a low molybdenum concentration in the laminae and a value of the order of 0.05 p.p.m. is tentatively regarded as a threshold value below which molybdenum deficiency in rubber may be suspected.

In regard to interaction effects with other nutrient elements, it was found that increased sulphate level reduced the concentration of molybdenum in the laminae, indicating that heavy sulphate applications in the field, especially under acid soil conditions, may depress molybdenum uptake. Calcium had no significant effect on molybdenum concentration in the tissues although the severity of the visual symptoms of molybdenum deficiency appeared to increase with increasing levels of calcium supply. It is concluded that the beneficial effect of lime on molybdenum uptake from soils must be attributed to its effect on the availability of molybdenum in the soil and not to any other specific effect of the calcium ions.

The concentrations of nitrate-nitrogen, sulphur, phosphorus and potassium in laminae decreased but that of manganese increased with increasing molybdenum supply.

Molybdenum deficient plants, when supplied with nitrogen in the form of nitrate, had smaller concentrations of chlorophyll and iron in the laminae and of phosphorus, calcium and iron in the roots, than those supplied with molybdenum.

*Effects of arsenic on rubber*—Because sodium arsenite is widely used as a weedkiller in rubber areas the effect of arsenic on rubber seedlings grown in sand was studied with a view to finding the best means of diagnosis in the field when ill effects due to absorption of arsenic via the roots are suspected. Most of the arsenic absorbed accumulates in the roots. The main effects of arsenic toxicity are: stunted growth, yellowing and premature abscission of the older leaves.

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## A D V I S O R Y

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The statistics relating to advisory work may be summarised as follows:

|                                |     |
|--------------------------------|-----|
| Letter reports despatched      | 443 |
| Visits to estates              | 61  |
| Interviews at the Institute    | 125 |
| Samples analysed in laboratory |     |
| Soil samples                   | 99  |
| Plant samples                  | 142 |
| Fertilisers                    | 24  |
| Weedkillers                    | 5   |

No important new trends in advisory work were noted.

## Manuring

As in previous years manuring was the subject which cropped up most frequently among a variety of enquiries by correspondence, accounting for 38% of the number of advisory letters despatched. It would seem that regular manuring of young high yielding mature rubber is becoming more widely accepted as a policy meriting consideration, and the need for manuring was more readily recognised when attention was drawn to symptoms of nutrient deficiency manifested by leaf discoloration. Several enquiries concerning abnormal features exhibited by leaves and requests for examination of leaf samples were received following publication of *Journal Communication* 300 in which nutrient deficiency symptoms are described and shown in coloured photographs. The frequent occurrence of magnesium deficiency symptoms, particularly in immature areas, was noted and attention was drawn to several mature rubber areas where potash deficiency was diagnosed. It is becoming increasingly evident that potash deficient soils are much more widespread than was previously thought, particularly in the northern part of the country.

Clear symptoms of manganese deficiency were observed in several areas, usually on light sandy soils, but none of these covered a large acreage. It has been shown that this nutritional disorder can be corrected by applications of small amounts of manganese sulphate. Symptoms of iron deficiency also were observed in a few, relatively small, scattered patches but there is still no evidence to suggest that trace element deficiency in an acute form is a major problem in rubber areas of Malaya.

Enquiries from several estates were received towards the end of the first half of the year concerning leaf discoloration in mature and the older immature areas which was followed by rather heavy leaf fall, confined mainly but not entirely to the lower branches. This was believed to be a form of secondary wintering probably associated with abnormally dry conditions.

## Weed Control

Advice on weed control accounted for 11 per cent of the number of advisory letters despatched. Sodium arsenite is the weedkiller that is still used most frequently on estates although increasing interest was shown in the use of Dowpon as a possible substitute. Managers of several estates carried out small scale trials with varying success and some estates have since been using Dowpon for routine control of grasses. Only one report of harmful effects on rubber was received. In this instance Dowpon was applied at the rate of 15 lb per acre whereas the recommended rate of application for control of the smaller grasses is 10 lb per acre. The heavier rate of application is recommended only for control of lalang.

Judged on observations made in small scale trials at the Experiment Station, however, it would seem that Dowpon is not completely satisfactory for routine control of grasses along planting rows in young rubber areas. Results vary, depending on the species of grass that is dominant. Dowpon kills most of the commonly occurring grasses such as *Axonopus compressus*, *Ischaemum muticum* and *Panicum* species but *Paspalum conjugatum* is markedly resistant and in areas where the latter is the dominant grass species, spraying with Dowpon cannot be recommended.

A few enquiries on control of lalang were received, mainly with reference to the use of Dowpon. The eradication of lalang, however, is no longer a major problem on the larger estates and it arises only when reserve or newly acquired lalang land is opened up for planting with rubber when it is a question of deciding whether the lalang should be eradicated by spraying or by mechanical cultivation.



Other weeds on which advice was sought include sedges, wild bananas and Bertam palm.

*Mechanical cultivation*—Only a few enquiries on mechanical cultivation were received but it was noted that increased use is being made of mechanised equipment on estates mainly for preparing land for planting or replanting. The trend towards mechanisation appears to be more advanced in the Malacca district than in other parts of the country. Several replantings on the smaller Asian rubber estates were seen where the land had been cleared, ploughed, harrowed and terraced by the use of hired tractors. An invitation to visit a group of large Asian owned estates in the same district was accepted and the tour was of considerable interest in that it afforded an opportunity to see the results of work done on a large scale by mechanised equipment. The operations carried out include clearing of large acreages of lalang land for planting by ploughing and harrowing, stumping in a jungle clearing, terracing on steep hillsides, cultivation in young replantings and mechanised spraying of weeds. The work done, some of it on difficult terrain, was of a high standard. Of particular interest was the terracing done on very steep hills, both in replantings and in a jungle clearing, using heavy D.4 and D.6 tractors with bulldozer attachment. The results were impressive.

Other enquiries received were concerned with replanting problems (30 letters), experiments conducted by estate staff (24) and ground covers (19). Advice based on examination of samples of soils, leaves, fertilisers and weedkillers sent for examination and/or analysis accounted for 24 per cent of the advisory letters despatched.

G. OWEN  
Head of Soils Division

## Botanical Division

Mr C. W. Brookson, the Head of Division, proceeded on long leave on 12 January. Mr P. de Jonge acted for him until his return on 24 July and in turn proceeded on leave on 29 July, until the end of the year. Dr P. R. Wycherley resumed duty after long leave on 25 February. Mr J. M. Ross commenced his long leave with effect from 6 December. Dr S. G. Boatman was on duty throughout the year. Mr T. V. Vaidyanathan resumed duty after long leave on 1 June. Mr V. K. Bhaskaran Nair resigned his appointment at the end of his first tour on 31 May.

Mr P. Martin, laboratory assistant on the Experiment Station resigned to take up appointment elsewhere.

The following field and laboratory assistants were appointed to fill existing vacancies and that created by the above resignation: Mr A. Gopalan, Mr A. Bhaskar Das, Mr Leong Wing, Mr Lee Yoon Chye and Mr K. Vasudevan. They were confirmed in their appointment.

Miss Liew Kon Yew, a typist of the Botanical Office resigned in the middle of the year. Miss Vong Yoke Lin was appointed in her stead and confirmed in her appointment.

Research Officers made eighty visits to Estates in connection with research work. The research visits were all concerned with the conduct of the Division's Experiments but included some advisory work. Field assistants made two hundred and two visits to Estates in connection with experiments, spending six hundred and seventyone days.

One hundred and sixtysix visits were made to the Rubber Research Institute Experiment Station by Graduate Officers in connection with the work at the Station.

Clone Inspectors were employed for four hundred days in visits to one hundred and ninety-six potential seed collection areas and in checking the identity of budwood.

Mr C. W. Brookson visited the Department of Agriculture, the University of Oxford, the John Innes Horticultural Research Institute and the Natural Rubber Development Board. A number of visits were also made to the London Advisory Committee, also to Cambridge University and Reading University in recruiting staff.

Mr P. de Jonge visited the Department of Agriculture, the University of Oxford, East Malling Research Station, the Horticultural Department Wageningen University and Messrs Philips to view electron microscopes.

Dr P. R. Wycherley attended the Ninth Pacific Science Congress at Bangkok from 16 to 31 November, 1957, and presented papers from Botanical and Pathological Division.

Mr M. K. Nambiar left for Borneo on 16 June, 1957 in order to inspect clonal seed collection areas and budwood nurseries. He visited 18 estates and stations, and was occupied for 37 days in Borneo.

Mr Wong Loy left for Indonesia on 20 December, 1957 to verify the identity of clone WR 101, in which he was successful despite disturbed conditions.

The Botanical Division laboratories at Sungei Buloh were re-occupied in May after minor alterations to improve the air-conditioned facilities had been completed.

The following articles were prepared for the *Planters' Bulletin* and published throughout the year: 'Tapping before Replanting' (a note), 'Clonal Trials' (a note), 'Planting Recommendations 1957-58,' 'Inspection of Approved Sources of Supply of Clonal Seed', 'Selection of Clonal Seed Collection Areas,' 'Tapping Young Rubber — Revised Recommendations,' 'Felling and Plant Collecting' (Editorial), 'RRIM 600 Series Clones', 'Multiplication and Testing of New Clones', 'Clone Abbreviation Code' (a note), 'Notching Dormant Buds' (a note), 'Clonal Seed Collection Areas in Malaya,' 'Despatch of Planting Material', 'Propagation of *Flemingia*', 'Breakage of

Clone RRIM 501' (a note), 'Thinning with 2,4,5-T' (a note), 'Identification of Clones' (a note).

Communication 305 by Mr P. de Jonge 'Stimulation of Bark Renewal and its Effect on Yield of Latex' was published in Volume 15, second part, of the *Journal of the Rubber Research Institute of Malaya*.

Two papers were presented by Dr P. R. Wycherley at the Ninth Pacific Science Congress at Bangkok. 'Vegetation of Rubber Estates' by Dr P. R. Wycherley 'Stimulation of Yield in *Hevea brasiliensis*' by Mr P. de Jonge.

Dr Wycherley's paper will appear in the *Journal of the Rubber Research Institute of Malaya*, Mr de Jonge's will appear in the 'Proceedings' of the Congress.

Work continues on projected *Journal* publications.

Dr P. R. Wycherley lectured on 'Hevea Planting Material in Practice' to the South Johore Branch of the Incorporated Society of Planters.

Sixty advisory visits were made to Estates in response to specific requests, usually concerned with planting material, yield stimulation and tapping. The one hundred and ninety-six visits by clone inspectors can also be classed as advisory. Research visits usually involve a large element of advisory work.

The total acreage approved for clonal seed collection as at 15 December, 1957 was 21,153. These areas are on 116 estates.

## RESEARCH

### BREEDING, SELECTION & TESTING

#### Hand Pollination

Eight thousand eight hundred and ninety hand pollinations were carried out in 1957 representing eleven different crosses. Five of the families were crosses with the *Dothi-della* resistant clone FX 25, using pollen only from the latter; two of the families failed to set fruit. Four hundred and forty-eight ripe fruits were harvested, giving a success of 5% on the average for all families.

#### FINAL RESULTS OF HAND POLLINATION 1957

| Family              | No. of<br>polli-<br>nations | No. of<br>fruit<br>har-<br>vested | % of<br>success | No. of<br>seeds<br>planted | No. of<br>seeds<br>germi-<br>nated | % germi-<br>nation |
|---------------------|-----------------------------|-----------------------------------|-----------------|----------------------------|------------------------------------|--------------------|
| GT x Tjir 1         | 136                         | 8                                 | 5.9             | 24                         | 17                                 | 70.8               |
| GT 1 x RRIM 612     | 1043                        | 70                                | 6.7             | 219                        | 176                                | 80.4               |
| PR 107 x RRIM 600   | 1083                        | 45                                | 4.2             | 135                        | 58                                 | 43.0               |
| PR 107 x RRIM 612   | 1127                        | 70                                | 6.2             | 209                        | 107                                | 51.2               |
| LCB 1320 x RRIM 623 | 232                         | 2                                 | 0.9             | 6                          | 5                                  | 83.3               |
| RRIM 600 x FX 25    | 656                         | 16                                | 2.4             | 48                         | 45                                 | 93.8               |
| Tjir 1 x FX 25      | 1211                        | 74                                | 6.1             | 222                        | 167                                | 75.2               |
| RRIM 501 x FX 25    | 1323                        | 80                                | 6.0             | 239                        | 220                                | 92.1               |
| Tjir 1 x LCB 1320   | 1256                        | 83                                | 6.6             | 249                        | 200                                | 80.3               |
| RRIM 612 x FX 25    | 659                         | —                                 | —               | —                          | —                                  | —                  |
| RRIM 623 x FX 25    | 164                         | —                                 | —               | —                          | —                                  | —                  |
| <b>Total</b>        | <b>8890</b>                 | <b>448</b>                        | <b>5.0</b>      | <b>1351</b>                | <b>995</b>                         | <b>73.6</b>        |



One thousand three hundred and fiftyone seeds were planted in baskets in the germination shed; nine hundred and ninetyfive germinated. The Table shows the families and the detailed results.

### *Seedling Families*

Seven hundred and twentythree seedling stumps were planted of the 1955 hand pollinated seedlings and nine hundred and ninetyfive basket plants of the 1957 hand pollinated seedlings were planted. Both these serials were employed in two single tree plot designs, with Tjir 1 illegitimate seed as control at the R.R.I. Experiment Station.

Examination of the results of tapping of the first year of the 1947 hand pollinated seedlings trial showed that the family RRIM 507 x Tjir 1 gave a favourable yield closely followed by the family Tjir 1 x RRIM 501.

A trial to compare the value of seedling families from the Smallholders seed garden at the R.R.I. Experiment Station was also set up. Other families of interest were included.

### *Clones*

Four hundred and seventytwo new clones were made from the 1955 hand pollinated seedlings and were budded in a simple lattice design field trial. Owing to shortage of space one hundred and fortyeight clones were budded in the nursery for future use.

At the R.R.I. Experiment Station the second year of tapping of the large scale trial of clones RRIM 600-618 was completed at the end of September. Clone RRIM 613 was the highest yielder but at the end of the tapping year had suffered a large number of casualties by wind break. In combination with other characters the promising clones at the end of the second year appeared to be RRIM 600, 603, 605, 607, 610 and 614. The yield records have been tabulated and at the end of the year were submitted for statistical analysis. The results will be published in the *Planters' Bulletin*.

The first year of tapping of clones RRIM 619-630 in large scale trial at the R.R.I. Experiment Station was completed by the middle of the year and the records, adjusted for block effects, were prepared for publication in the *Planters' Bulletin* as early as possible in 1958. RRIM 623 appears to be most promising in the trial on yield and secondary characters.

## TRIALS OF SELECTED PLANTING MATERIALS ON ESTATES

### *Projected Trials*

An area for a further large scale trial was surveyed on an estate.

### *Mature Trials*

All large scale trials received routine visits by field assistants and at least one visit by a Research Officer during the year. Normal routine records were checked and observations made.

Two of the distributed block trials of the RRIM 600 series clones on estates, were opened for tapping in 1956 and completed their first year of tapping in December, 1957.

### *Immature Trials*

Of the distributed block trials eleven further blocks on estates were opened for tapping during the year. Most of those remaining are expected to be brought into tapping during 1958.

The second of the postwar RRIM 500 series clones trials was opened for tapping on 1 May, 1957. The first trial completed its first year of tapping during the year.

In the trials to compare ninetyone clones from South East Asia (the Exchange Clones), the four lattices of all trials were budded and lattices A, B and C were cut back by the end of the year.

#### PROPAGATION AND PLANTING TECHNIQUE

##### *Planting Technique*

The panel clones were budded in a trial (simple lattice and split plot design) to determine the effects of nine *Dothidella* resistant clones top budded on three high yielding eastern clones.

In a preliminary experiment the girth increment subsequent to crown budding appears to be determined by the nature of the crown clone; the panel clone has little effect.

Reports of damage by wind to clone RRIM 501 in a limited area were received during the year. A report on the subject was prepared for the *Planters' Bulletin* with recommendations regarding manuring.

Girth increments continue to be less for trees planted according to 'hedge systems' compared with those trees planted more regularly. Four clones are employed in this trial in which field budding was completed in 1953.

##### *Tree Poisoning*

Pending the discovery of an efficient tree poison with no mammalian toxicity, no further work was done on this subject. Trees poisoned with 2,4,5-trichlorophenoxy-acetic acid at the R.R.I. Experiment Station showed a distinct tendency to fall as a whole, in contradistinction to the fragmenting effect of sodium arsenite.

##### *Vegetative Propagation of Hevea brasiliensis*

Attempts were made to root cuttings from young seedlings and from buddings of RRIM 622 and PR 107. The cuttings were set in coarse sand in a greenhouse, in which a pump maintained a spray of water during the hours of daylight. The nature of this arrangement was not satisfactory, because more rapid success in rooting juvenile seedling cuttings was obtained in the open than in the greenhouse. No success was obtained with either green leafy, or brown woody cuttings from buddings. Most cuttings from buddings died, mainly from fungal infections, without forming any callus; whereas seedling cuttings remained comparatively healthy and produced both callus and roots during the same period. In one series of 72 cuttings from RRIM 622 buddings, three produced callus, but no roots, before dying four months after cutting.

No effect was obtained by painting the leaves or soaking the cut stems in extracts of young seedling leaves in a small scale test. The leaves were extracted with hot and cold ether, alcohol and water separately; 1 ml of the final aqueous suspension for soaking was equivalent to 1 gm of leaves fresh weight, while the paints were four times as concentrated. Half the cuttings received treatment with indoleacetic acid also.

The rooted leaf cuttings previously reported have failed to produce shoots. A new research programme has been set up in which various methods will be tried to establish high yielding clones on their own roots. Attempts will be made to develop legitimate stock material for budding. This programme has been designed in close cooperation with the East Malling Research Station, Maidstone, Kent. It has also been agreed that Mr R. J. Garner of this latter Research Station will spend part of the year 1958 in Malaya to take charge of the initial investigations.

### *Stock Scion Relationship*

Analysis of nine prewar stock scion experiments has not yet been fully completed but results available show no significant differences between the twelve different types of illegitimate seedling families with regard to growth, yield and bark thickness of the scions.

The families AVROS 163 and Pil B84 illegitimate appeared to be better than the others, but not with statistical significance. Tjir 1 illegitimate gave variable results — in some cases it looked promising especially when clone Tjir 1 was budded onto it, but in other cases almost significant depressing effects have been recorded.

The large variability within these illegitimate seedling families doom these experiments to yield insignificant results and only when legitimate uniform stock material can be produced, can stock scion experiments be expected to yield clear information.

A stimulating effect on girth and bark thickness has been recorded in a postwar experiment when using *Hevea spruceana* hybrid stocks as compared to *Hevea brasiliensis* unselected seedlings: the effect is significant where PB 86 is the scion. Tapping of this experiment began during the year.

### TAPPING

#### *Full Spiral Tapping Experiments*

These experiments are being discontinued gradually and the results are subjected to statistical analysis.

#### *Tapping Experiments on Planting Material Sensitive to Brown Bast*

An experiment carried out on clone Glenshiel 1 has shown that continuous third daily tapping of a half spiral cut is the most suitable system for this clone, giving maximum yield and low brown bast incidence. Third daily tapping yielded a similar amount to alternate daily tapping during the fourth year of tapping.

Another experiment is carried out on young PBIG seedlings. The second year of tapping has been concluded and the third daily tapped tasks yielded 19% less than the tasks tapped alternate daily. The brown bast incidence was 2.2% for third daily and 6.6% for alternate daily tapping. Treatment with a yield stimulant was discontinued because of the retarding effect on growth. Those tasks which had been treated with a yield stimulant in the past, showed a high dry-tree incidence eighteen months after the application of the stimulant.

#### *High or Ladder Tapping*

Experiments continued on seedling and budded trees and records were collected from monoclonal areas tapped on high cuts on estates.

Trees of high yield capacity but low yielding because of poor bark renewal respond favourably to ladder tapping. The high initial yield level decreases as the cut moves downward towards the junction of virgin and renewed bark.

Trees of low yield capacity do not respond with an increased yield to ladder tapping.

#### *Intensive Tapping*

Experiments carried out on budded and seedling trees have shown that high yielding planting material should not be tapped alternate daily on two half circumference cuts as there is a depressing effect between cuts.



Third daily tapping of two cuts (2C/2.d 3.133%) may be a more attractive proposition for such material. This is being tried out in a field of 18 years old high yielding buddings.

Low yielding clones and unselected seedling trees can be tapped alternate daily on two half circumference cuts (2C 2.d/2.100%) for a prolonged period. No interference between cuts was observed after 2½ years of intensive tapping.

Different methods of application of a yield stimulant in combination with 2C/2.d/2.200% tapping showed a positive effect for not longer than 1½ – 2 years irrespective of the method of application.

#### *Interaction between Tapping, Stimulation and Manuring*

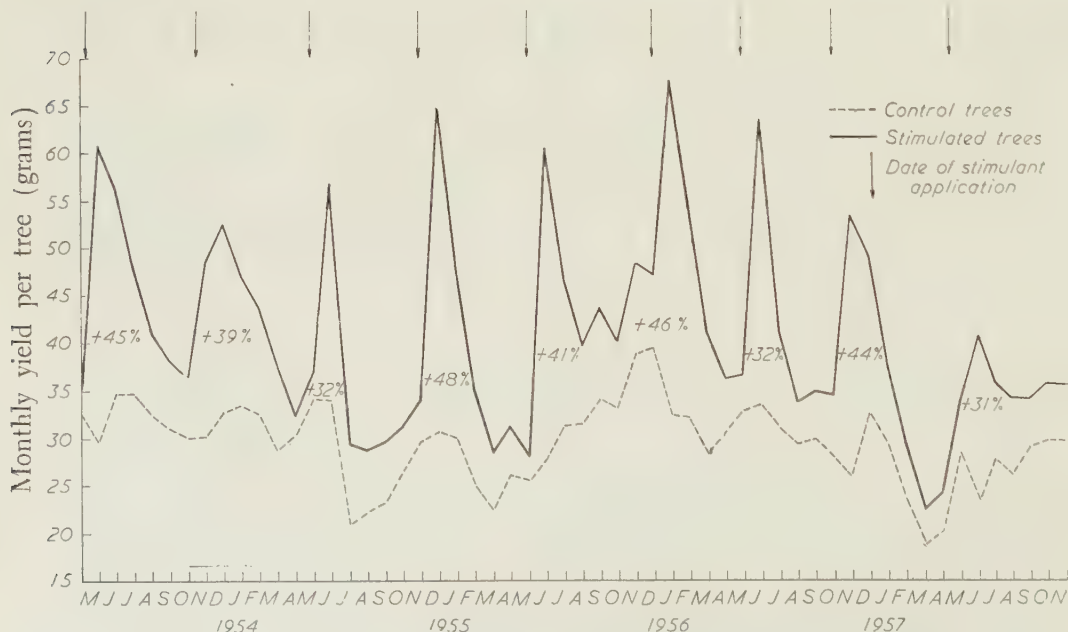
An experiment has been commenced on a cooperating estate using clone PB 86, in which S 2.d/2.100% and S/2.d/3.67% confounded with yield stimulant application are compared at two levels of manuring. This experiment is in cooperation with the Soils Division.

A second experiment is carried out in cooperation with the research unit of a leading rubber Company in which three tapping systems are compared at four levels of manuring on budded trees of clone PB 86. No experimental data are yet available.

### PHYSIOLOGY AND MORPHOLOGY

#### *Yield Stimulation*

Two long term experiments, one on clonal seedlings and one on buddings of nine clones, continue. A graph of the progress of the latter experiment is shown. A positive response to the yield stimulant is still obtained after five years of continued half yearly application.



R.R.I. Experiment Station Field 5. Half yearly stimulant application:  
mean monthly yield in grams per tree tapping.

A frequency of application experiment carried out on clonal seedlings tapped on bark of second renewal has shown that after two years of tapping the best yield was obtained by the treatment in which the stimulant was applied at three months intervals below the tapping cut. An increase in yield of plus 61% was recorded over the two year period. Application at six months intervals yielded plus 31% over the control. Monthly application above the cut increased the yield with plus 33% but the treated bark became seriously damaged.

The experiment in which upward and downward tapping of old seedling trees is confounded with stimulant application has been discontinued. Upward tapping appears practicable for a period limited by its high bark consumption. The response of upward tapping of a half circumference cut to yield stimulant application is clearly better than if tapping of a high V/2 cut is done in a downward direction.

The experiment to find the optimum concentration of 2,4,5-T in the palm oil petrolatum mixed for application to scraped bark below the cut has been discontinued. The optimum concentration appeared between 1 - 1.5% acid equivalent of 2,4,5-T.

Two experiments are in progress on juvenile type buddings, tapped in good bark of first renewal, in which alternate daily and third daily tapped intensive tapping systems are under comparison confounded with application of yield stimulant. Only five months results are available, which show distinctly better reactions of the third daily systems to application of the yield stimulant.

A number of screening tests of plant growth substances for yield stimulation ability were set up and are reported in sequence.

In Field 46 at the R.R.I. Experiment Station newly-opened trees of clones PR 107 and AVROS 352, budded in March, 1949, were treated with growth substances above the tapping cut and the effects on yield and bark renewal followed for a period of six months. Yield recording, by cup coagulation at each tapping, was started soon after opening in June, 1956 and the first application of treatments was made at the beginning of January, 1957. Twelve treatments were allocated on a randomised tree-plot design, each treatment receiving 15 or 16 trees. The treatments were applied at monthly intervals to a one-inch strip of renewing bark immediately above the tapping cut. Vaseline was used as the carrier for all the treatments except treatment 12 (coconut milk concentrated by freeze-drying).

The treatments were as follows:

- 1 Control, no treatment
- 2 0.9% acid equivalent n-butyl ester of 2,4-D
- 3 0.9% acid equivalent n-butyl ester of 2,4,5-T
- 4 0.9% 2,4,5-T acid
- 5 0.3% } 2,4,6-trichlorophenoxyacetic acid
- 6 0.9% }
- 7 2.7% }
- 8 0.3% } acid equivalent n-butyl ester of 2,4-dichloro-5-fluorophenoxyacetic acid
- 9 0.9% }
- 10 2.7% }
- 11 0.9% sym-diphenyl urea
- 12 Coconut concentrated by freeze-drying to a thick syrup (about 1/20th original volume).

Of the experimental treatments, 2,4,6-T, diphenyl urea and coconut milk were inactive as yield stimulants. The n-butyl ester of 2,4,5-T at 0.9% acid equivalent consistently out-yielded the corresponding 2,4-D treatment, averaging 136% of the control

yield over the six months, compared with 115%. The ester of 2,4-dichloro-5-fluorophenoxyacetic acid showed about the same level of activity at 0.9% a.e. (131% of control) and gave a still higher response (152%) at the 2.7% level.

The thickness of the renewing bark treated in the first application was measured at monthly intervals and compared with that of the virgin bark immediately below the tapping cut. All the treatments active in yield stimulation caused marked increase in the thickness of the renewed bark, the effect being most marked in the highest-yielding treatments. There was also some slight improvement over control in the treatments inactive as yield stimulants. This was attributed to the vaseline carrier, which has been shown to cause significantly increased bark renewal during the first few months after application in this manner. In the 2,4,5-T treatments and the two higher concentrations of 2,4-dichloro-5-fluorophenoxyacetic acid there were numerous instances in which the treated bark was grossly swollen and cracked. Some bark damage of this nature was also observed in the case of the 2,4-D treatment, but it was on the whole less severe.

In Field 25(v) at the R.R.I. Experiment Station a further eleven compounds supplied by Professor Blackman of the Department of Agriculture, University of Oxford, were undergoing test on 26-year-old clonal seedling trees, but no results were available at the close of the year.

A procedure was developed for the rapid preliminary screening of plant growth substances in order to select compounds for larger scale experiments. Some sixteen compounds were tested in Field 14E (ii) at the R.R.I. Experiment Station before the end of the year and several of the more promising were selected for further study.

A series of experiments were set up to investigate the effect of gibberellic acid on the germination of hevea seeds, growth of seedlings, shooting of buddings and stimulation of latex flow. Full results were not available but early indications were disappointing.

Three field experiments were set up in cooperation with Chemical Division to compare methods of yield stimulation by bactericides and plant growth substances.

#### *Translocation of Growth Substances*

Work continued on the study of bioassay methods with some prospect of success.

#### *Anatomy*

Routine work only continued.

#### *Water Relations of Hevea Bark*

Experiments over a wide range of concentrations failed to show any effect of the potassium salt of 2,4,5-T on the water content of hevea bark disks in water, sucrose or mannitol solutions. In a parallel series of experiments, however, the application of the R.R.I. formulation of 1% acid equivalent of the n-butyl ester of 2,4,5-T to patches of scraped virgin bark of mature seedling trees caused increases in water content of 1.6% compared with control patches on the same trees. Analysis of reducing sugars and sucrose failed to show any consistent differences between treated and untreated bark.

#### *Auxin Content of Latex*

Small scale field tests have shown that naturally occurring indole compounds, especially indole-3-acetic acid are highly active yield stimulants. This has led to renewed interest in the natural auxin content of latex. Despite the reported occurrence



of indoleacetic acid in hevea leaves, it has not been possible to demonstrate its presence in latex using similar methods of paper chromatography and the *Avena* coleoptile straight growth test. At least one active ether-soluble indole compound, as yet unidentified, has been shown to be present.

#### ECOLOGY

##### Cover Plants

A creeping legume, with considerable promise in view of its good seed set under local conditions and a measure of shade tolerance, has been identified as *Clitoria rubiginosa*.

##### Field Experiments

The trials in Fields 23 and 24 at the R.R.I. Experiment Station have been selectively weeded and desired species supplied, so that virtually pure covers according to treatment have been achieved. Field 24 has been budded with GT 1 in the trial area.

Portions of the replanting in Field 6 at the R.R.I. Experiment Station have been planted with grass and legumes to permit an investigation of the effects of mowing and special fertilisation, in a split plot design. Creeping legumes and *Flemingia congesta* form the covers in the remainder of the field.

##### Seed Testing

During the year 122 commercial samples of cover crop seed were tested. Development of improved methods of promoting germination continued.

Gibberellic acid solutions of 0, 1, 10 and 100 ppm were confounded with pretreatment by cutting the testa and no pretreatment in germination tests on seed of four leguminous cover species. In all species pretreatment by cutting gave highly significant increases in germination, but only in the case of *Flemingia congesta* was an additional advantage obtained due to gibberellic acid after pretreatment by cutting. For seeds which did not receive cutting pretreatment 10 ppm gibberellic acid led to significantly lower germination relative to control in *Centrosema pubescens* and *Pueraria phaseoloides*. No other significant results were obtained, although in *Calopogonium mucunoides* 10 ppm gibberellic acid gave the best germination without pretreatment and the worst after cutting. In that no significant improvement in seed germination without cutting pretreatment was obtained over the range of concentrations studied, gibberellic acid appears to be of no value for practical use in this field.

##### Identification & Distribution of Material

Seed of *Flemingia congesta* was distributed to 23 estates. Naturally occurring plants were identified for 24 estates.

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#### ADVISORY

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A further increase in the amount of correspondence received and despatched was noted. Three thousand five hundred and eightyseven letters were received during the year, three thousand nine hundred and sixty letters were dispatched. Two thousand three hundred and ten letters received and two thousand five hundred and fifty despatched were of a purely advisory nature; the increase in correspondence is solely on the advisory side. Internal correspondence amounts to nine hundred and one; corres-

pondence with the Manager, Rubber Research Institute Experiment Station, three hundred and thirtytwo. Correspondence relating to experimental planting on estates consisted of seven hundred and fiftyseven letters received and six hundred and sixty-eight letters despatched.

Ninetytwo visitors also called upon the Division.

The analysis of advisory correspondence follows.

#### *Breeding and Selection*

Thirtyseven enquiries were received regarding seed gardens and their establishment, and four hundred and seventy largely with regard to identification of trees in prospective seed collection areas; a few only of the queries being requests for nursery identification of budwood.

Five hundred and fortysix letters were received concerning the choice of clones for planting; thirtyfive concerning the choice of seedling families. Thirtyfour letters dealt with the exchange, despatch and receipt of planting material. Thirtyfour letters dealt with the identification of rubber seeds.

#### *Propagation and Planting Technique*

One hundred and sixtythree queries were received under this heading concerning hedge planting, planting distances and densities; seventeen concerning tree poisoning.

#### *Tapping*

One hundred and eight queries were received on subjects under this heading, mainly on intensive tapping prior to replanting.

#### *Physiology*

Sixtytwo letters were received, mainly on the subject of yield stimulation.

#### *Ecology*

Eightynine letters were received concerning the identification of cover plants.

#### *General Planting Enquiries*

Six hundred and fourteen queries on general subjects were received.

C. W. BROOKSON  
Head of Botanical Division

AN ILLUSTRATED NOTE ON *CLITORIA RUBIGINOSA* JUSS. EX. PERS.

In *Clitoria* and certain other genera, e.g. *Centrosema*, the flower stalk is twisted so that the standard petal is below and the longest sepal is above. The majority of the flowers produced by *Clitoria rubiginosa* in Malaya lack petals, but a few flowers with petals have been borne. Two of these are illustrated in Figures 1 and 2; it will be seen that the orientation of the flowers is typical of the genus.



Figure 1



Figure 2



Figure 3

An apetalous flower is illustrated in Figure 3; it will be seen that the long sepal is downward, i.e. the usual orientation of Papilionate flowers, but atypical of *Clitoria*.

All specimens of petaloid flowers show the typical *Clitoria* orientation before and after opening, but the apetalous flowers are variable. In the latter the turning from long sepal downward to upward sometimes takes place after cleistogamous fertilisation.



The lack of petaloid flowers until this year contributed to the difficulties in obtaining an identification, which was finally determined by Professor Dr W. Robyns of the Jardin Botanique de l'Etat, Bruxelles.

The pods are the same irrespective of flower type. An opened pod to show the sticky seed is illustrated in Figure 4. It is very similar in structure to that of *Clitoria laurifolia* Poir.

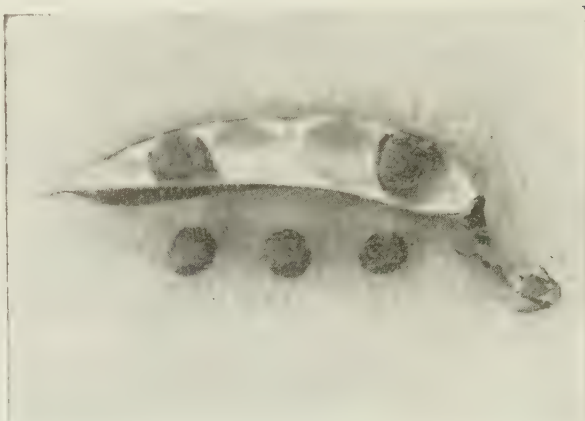


Figure 4

## Pathological Division

The Field Research Officer (Mr F. W. Hutchison) returned from long leave on 3 January. The Pathologist (Mr R. N. Hilton) and Microbiologist (Mr R. A. Fox) both went on long leave on 5 March. Mr Fox returned to duty on 23 September, Mr Hilton on 30 September. They had both attended the 4th International Congress of Crop Protection held at Hamburg, Germany, from 9 to 14 September. The Head of Division (Dr A. Newsam), Assistant Pathologist (Mr K. P. John) and Assistant Entomologist (Mr B. S. Rao) were on duty throughout the year.

A paper entitled 'Susceptibility of Hevea Seedlings to *Helminthosporium heveae* Attack in Relation to their Nutrient Status', jointly by Dr Bolle-Jones of the Soils Division and Mr Hilton, was published in the *Journal* as Communication 307.

Fortyone coloured plates to illustrate a manual of diseases of hevea were given to a printer in the United Kingdom who will be executing the work, and preliminary proofs were received.

Advisory articles contributed to *Planters' Bulletin* were entitled: 'Scale Insects and Mealy Bugs'; 'Decaying Timber Spreads Root Disease'; 'Pests of Legume Cover Crops', and 'Despatch of Pathological Specimens'. In addition, five short notes on pathological subjects were contributed, and material for an editorial.

Mr Hilton gave a lecture on plant protection to the North Johore branch of the Incorporated Society of Planters.

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### RESEARCH

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#### ROOT DISEASES

The spread of white root disease on the roots of artificially inoculated trees has been followed over a period of a year both when the rhizomorphs were allowed to grow unhindered and when external growth on the roots was suppressed. The rate of progress of the disease was so slow in the absence of external growth that the trees were to some extent able to resist further invasion; in some instances the infection was cut off and the wound started to heal over. These findings have led us to intensify our search for a material that will prevent external growth of root parasites on the roots. With the same objective, manufacturers of fungicides have been invited to furnish, for further testing here, substances which might be expected to retain their activity when used as a soil drench.

Of our long term field experiments on estates, one (G-50) laid down in 1950 has been terminated; two (CI-51 and CI-56) are being continued, while two new experiments (SR-57 and J-57) have been started. Experiment G-50 has confirmed the superiority of the recommended method of stump poisoning with sodium arsenite — by applying a paste to the ring barked top of the stump. Experiment CI-56 has shown little difference between the effectiveness of sodium arsenite and normal butyl 2,4,5-T, as judged by the rate of death of the roots of poisoned stumps and trees which were later felled. The experiment is designed to compare the resulting incidence of root disease in the replanting, following each treatment. Experiment CI-51 has shown that routine control measures that have long been advised, though eliminating root disease

in the end, have meanwhile the undesirable effect of increasing the incidence of infection on the replanted stand. Periodic tree-to-tree collar inspection during immaturity has, accordingly, been dropped from our recommendations. The two new experiments have been put down to investigate methods of eradicating diseased trees from the old stand prior to replanting, and the effects of surface timber in spreading root disease. SR-57 is sited on alluvial clay where white root disease is dominant, while red root disease is dominant on the inland soil of experiment J-57.

A fundamental study of the root diseases is proceeding. Fructifications of the three major root disease fungi are being studied microscopically to help resolve doubts as to their identities. Even the name *Fomes lignosus* is dubious and will have to be changed or the species redescribed in due course. Isolates of white root disease from many sources have shown physiological differences in culture. Their growth in relation to pH has been further studied, at constant temperatures. A Warburg apparatus that is to be used in growth studies of various kinds has been calibrated. Roots have been sectioned to observe the site and mode of entry of the fungus.

More than 3,600 returns were received from the Rubber Industry (Replanting) Board in connection with their survey of the root disease position on smallholders' 1953 replantings, which we suggested, in consultation with the Smallholders' Advisory Officer. Analysis of the data has been delayed by the Power-Samas installation not being ready.

Sodium arsenite, applied as a paste after ring barking, has been compared with butyl 2,4,5-T, brushed on to intact bark, as a stump and tree poison. Poisoned trees were not left standing but were felled at various periods after poisoning. Differences between the two poisons were not evident from the rate of death of the roots. Though both methods are used with success to poison standing trees, felling treated trees at intervals after poisoning progressively reduced the effectiveness of the poisons. Notwithstanding these findings, erratic results are sometimes reported when 2,4,5-T is used on estates. One possible explanation is provided by the observation that tapping panels impede the translocation of the poison. The condition of the bark low on the tree may therefore be a significant factor. Consideration has been given to various ways of improving on the performance of 2,4,5-T. The indications are that more extensive coverage of the bark, using a more dilute solution, may give better results. Also, addition of boric acid has given a strikingly more rapid kill, leading to earlier decay of stumps. Alternative poisons tested have given disappointing results; CMU applied at the rate of 30 grams per tree failed to induce even foliage symptoms, and the sodium salt of 2,4,5-T was of little use.

An interesting relationship between the degree of kill of roots and the extent of their invasion by root diseases was found when the poisoned trees were opened up for examination. The more successful the treatment, the higher was the incidence of disease. Among thirty trees that received the most successful treatment (high volume application of a low concentration of 2,4,5-T) there were twenty cases of *Ustulina zonata* and seven of *F.lignosus*, yet neither disease was found on the roots of trees that received the least successful treatment (CMU).

A start has been made with an investigation of the rate of decay, and of the organisms causing decay, of rubber timber. One approach is partly experimental, using insecticides to restrict the insect population, for comparative studies. The other approach is to observe the state of decay reached by timber under various conditions. In an area where old rubber trees were felled after poisoning and were soon covered by a heavy growth of creeping legume cover, it was estimated that 20% of the wood was broken down to humus in one year; 60% in two. Decay was due mostly to fungal attack.



## PANEL DISEASES

Following up the work carried out at Long Ashton Research Station on the fungicidal activity of tar oil fractions, a commercial producer sent five fractions for evaluation against mouldy rot. Only one reached the standard required for a fungicide to be approved, the limiting factor being their toxicity to newly tapped bark. A proprietary tar acid fungicide (Sanitas Okol) sent for testing by another manufacturer has received official approval, having been found to reach the required standard of effectiveness when used at a concentration of 30%. Two other proprietary materials have been under test.

A report that improved control of mouldy rot could be obtained with a mixture of Fylomac 90 and Izal led to the mixture being tested in the field. A mixture containing 1.25% Fylomac 90 and 5% Izal was non-toxic to renewing bark, although Fylomac 90 at 1.25% and Izal at 5% applied separately both caused bark damage. Assessment of the mixture against mouldy rot has not been completed.

## LEAF DISEASES

The annual survey of secondary leaf fall has been carried out as usual on specimens sent in response to a circular to estates and Rubber Instructors. The distribution of reports and the results of examining 214 specimens, expressed as in previous years, are given in the Tables. The season was short, 80% of the reports being in March, and the leaf fall generally slight. The dominant parasite was *Oidium*, followed by mites, *Gloeosporium* and thrips in the usual descending order of importance.

## DISTRIBUTION OF REPORTED OUTBREAKS OF SECONDARY LEAF FALL

| Territory            | March | April | May | Total |
|----------------------|-------|-------|-----|-------|
| Perak                | 9     | —     | —   | 9     |
| Selangor             | 11    | 2     | 1   | 14    |
| Negri Sembilan       | 17    | —     | —   | 17    |
| Malacca              | —     | 1     | —   | 1     |
| Johore and Singapore | 4     | 5     | —   | 9     |
| Pahang               | 3     | 2     | —   | 5     |
| <i>Total</i>         | 44    | 10    | 1   | 55    |

## INCIDENCE OF THE PARASITES ASSOCIATED WITH CASES OF SECONDARY LEAF FALL

| Parasite            | Percentages of cases in which |                           | Mean intensity of attack |
|---------------------|-------------------------------|---------------------------|--------------------------|
|                     | present                       | no other parasite present |                          |
|                     | March                         | April                     |                          |
| <i>Oidium</i>       | 86                            | 10                        | 5.6                      |
| <i>Gloeosporium</i> | 27                            | 7                         | —                        |
| Mites               | 81                            | 11                        | —                        |
| Thrips              | 26                            | 3                         | —                        |

Attempts to control bird's eye spot were resumed with a comparison between the commercial products Parzate, Zerlate, Perenox, mercurised copper oxychloride and Phelam. A Duleaver pump was used to apply 50 grams of each material in 10 litres of water to duplicated one-twelfth-acre plots at weekly intervals. The mean weights of harvested plants put the treatments in the order: mercurised copper oxychloride (114 g), Perenox (90 g), Zerlate (88 g), Phelam (79 g), and Parzate (74 g), a difference of 12.6 g being significant at the 5% level.

A motorised knapsack mist blower was used to follow up the promising results obtained with mercurised copper oxychloride. Two other proprietary materials included in the trial — Tufungol and Triscabal — had given good control of the disease in Indonesia. At the close of the year only MCO had brought about any marked reduction in the disease.

Plants have also been fogged with the commercial oil-soluble copper fungicide Schlofog. Although no reduction of disease was noted in this initial test, it is considered that fogging is a promising method.

#### BRANCH DISEASES

A study of pink disease is proceeding, with emphasis on its dissemination. The nature and time of spore production are now fairly well understood, but repeated attempts to bring about artificial inoculations with spores have still not succeeded, even though applied to the branches of the highly susceptible clone RRIM 501. A census of infected trees has been carried out on the Experiment Station to observe differences in clonal susceptibility, and to relate the incidence of disease to fertiliser treatments. No effect of phosphorus or potassium was found, but with an increase in the level of nitrogen the incidence of disease was higher. A new synthetic fungicide has been found to be about as effective for pink disease treatment as is Fylomac 90, to which it is chemically related.

A survey of pink disease on estates was carried out by post. The response was good, and clearly showed a great difference in incidence on inland and on coastal soils, the latter being almost free of infection. Nineteen of the estates that returned answers in the survey were visited: they included most of those that were exceptional in reporting pink disease on a coastal soil. Only in the Teluk Anson district was more than the odd case confirmed on a deep alluvial clay.

#### PESTS

Observations on the residual toxicity to *Coptotermes curvignathus* of soil treated with chlorinated hydrocarbons have been in progress for several years and are approaching completion. After 34 months, dieldrin has lost its toxicity in clay but remains active in all other soils with the exception of peat. The other three insecticides tested — chlordane, aldrin and endrin — had earlier lost their effectiveness in all the soils. The study of insecticidal activity in peat, which rapidly inactivates all of them at dosages which are fully effective in other soils, is being pursued at much increased dosage rates.

Seven outbreaks of cockchafer grubs, four of *Psilopholis vestita* and three of *Holotrichia bidentata*, were reported by estates in Perak, Pahang, Negri Sembilan and Malacca. The former species involved both mature and immature rubber, and the latter only immature rubber. Treatment similar to that adopted against termites — watering the soil with aqueous emulsion of insecticides — has been tried as a method of protecting immature trees in four of the outbreak areas. Four pints of 0.1% aldrin

or 0.04% gamma BHC gave complete control of the feeding grubs of *Holotrichia bidentata*. Gamma BHC appeared to be quicker in its action than aldrin, but it is known that aldrin will persist much better in the soil.

Insecticidal applications designed to protect scorched trees from invasion by boring beetles have been unsuccessful. It appears that the parts of the tree penetrated by the borers are already damaged beyond recovery, and that the beetles do not make the condition any worse.

A new case of infestation by caterpillars feeding on the superficial bark of three-year-old PB 86 trees, each enclosed in its own shelter, was recorded on an estate in Selangor.

Tests with insecticides against pests of legume covers have shown DDT to give good results against the ladybird beetle *Epilachna indica*, while endrin is preferred for treating caterpillars.

Cross inoculation tests with root-knot nematodes derived from five common legume covers — *Centrosema pubescens*, *Pueraria phaseoloides*, *Calopogonium mucunoides*, *Desmodium ovalifolium* and *Flemingia congesta* — have shown that they comprise four distinct strains or species, with different host ranges. One of them was able to penetrate the roots of rubber seedlings planted in infected pots.

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## ADVISORY

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The amount of advisory correspondence has, over the last few years, progressively fallen off. Half as many enquiries were dealt with by correspondence in 1957 as in 1956. This is regarded as an effect of the steadily increasing coverage of the subject by articles in *Planters' Bulletin*, which is the best medium for presenting generalised advice. Specific problems are best dealt with by inspecting the affected area. The number of advisory visits to estates has increased over last year; it will rise further because managers or estates are being encouraged to ask for a visit when they are confronted by a pathological problem.

### Root Diseases

There have been the usual requests for identification of fungi suspected of causing root disease. Harmless saprophytes that produce white rhizomorphs can be mistaken for white root disease, unless penetration of rubber roots is taken as the guide. Another error sometimes made is to regard any bracket fungus as indicating a source of infection. The root parasites can be identified from their fructifications, but it is preferable, in the field, to take account only of those sources traced back from infected trees. Most of the other enquiries concerned control measures in replantings, on which subject our views have been undergoing a change in the light of experimental findings, and on the effects of preplanting eradication of sources of disease. Some interest has been taken in control measures in older rubber, where the choice between trenching to isolate disease patches, or treating the disease, is not easy to make. Another possible solution that has been considered but not investigated is to poison trees bounding disease patches. Other root disease subjects raised included the effects of different methods used to clear old rubber, and of leaving timber on the ground in a replanting. Field Assistants have carried out root disease inspection work or demonstrated control measures on a few estates — this being a service that we plan to expand.



### *Other Diseases*

A harmless mould growth that forms on the renewing bark of panels treated with Fylomac 90 is sometimes mistaken for uncontrolled mouldy rot. Similarly, a terminal branch dieback which requires no treatment is sometimes mistaken for pink disease. These examples show the importance of correctly identifying diseases — a task that will be made easier when the illustrated manual of diseases appears.

### *Failure to Set Seed*

A report of poor seed set in a seed garden having drawn attention to the inadequacy of our knowledge of the effects of pests and diseases of flowers, plans have been made for regular observations of flowers, and for a dusting experiment, to be made during the next flowering season.

### *Pests*

In addition to the usual reports of localised outbreaks of various pests, two new ones have been recorded: lac insects on the branches of buddings five years old; cockchafer beetles eating the lower leaves of young seedlings. There have also been a few locally serious outbreaks of cockchafer grubs. Pests attacking legume covers have been more than usually troublesome.

### *Death of Bark*

A severe drought, which was widespread early in the year, in a few localities led to death of the bark on the trunk of clones Glen 1, RRIM 501 and PB 6/9.

### *Root Nodule Bacteria*

The demand for packaged *Rhizobium* compost culture for inoculating seed of legume covers has continued to increase. More than eleven thousand packets were distributed.

### *Summary of Advisory Work and Correspondence*

|                                     |     |
|-------------------------------------|-----|
| Letters despatched                  | 392 |
| Specimens examined                  | 722 |
| Visits to estates and smallholdings | 262 |
| Interviews                          | 91  |

ARTHUR NEWSAM  
Head of Pathological Division

## *Chemical Division*

At the commencement of 1957, the graduate staff of the Division comprised Mr W. G. Wren (Head of Division), Mr G. W. Drake, Dr W. A. Southorn, Mr H. M. Edmondson, Mr R. S. Gale, Mr J. E. Morris, Mr D. H. Taysum, Mr G. F. J. Moir, Mr B. C. Sekhar, Mr K. C. Sekar, Mr R. C. H. Hsia, Mr S. J. Tata, Mr S. T. Sethu, Mr Chong Yoon Hin.

Mr D. J. Graham continued to divide his duties between Chemical Division and Experiment Station Staff.

The Head of Division proceeded on leave in March and returned to Malaya in December, having spent two months full time duty in the United Kingdom. Mr G. W. Drake acted as Head of Division during Mr Wren's absence. Mr Graham went on leave in May. Mr K. C. Sekar took leave from May until September. Mr R. C. H. Hsia was in the U.K. on study leave for the whole of the year. Mr S. T. Sethu proceeded to the U.K. for two years study leave in September.

Mr Chong Yoon Hin, Assistant Biochemist, resigned in January. Mr H. M. Edmondson, Rubber Technologist to the Division, proceeded on leave in March and resigned in July. Dr Southorn returned from leave in January, and Mr Morris in February.

Mr T. V. Molesworth, Chemical Engineer, and Mr C. A. K. Salgado, Rubber Technologist in charge of Technically Classified Rubber, joined the staff in April. Mr A. Karunakaran, Assistant Biochemist, was appointed in December.

The post of Rubber Technologist still remained vacant at the close of the year. The post of Analyst remained vacant throughout the year. Attempts to recruit a Latex Technologist were unsuccessful.

The Division has continued to maintain liaison between the Committee of Malayan Latex Technologists and the British Standards Institution Sub-Committee RUC/10/7, which deals with methods of latex testing. Contact has also been maintained with Committee D-11, Sub-Committees of the American Society for Testing Materials, which deal with latex and with raw rubber. Exchange of views has been continued with sister Research Institutes, and with the International Rubber Research Board and the International Rubber Development Committee.

Two members of the staff, Dr Southorn and Mr Gale, visited the Institut des Recherches sur le Caoutchouc au Vietnam during May, for discussions on control of T.C. rubber and new methods of preparing dry rubber from latex. Mr Drake read a paper at the meeting of the Ninth Pacific Science Congress in Bangkok in November.

The Head of Division whilst on duty in the U.K. spent two weeks with the British Rubber Producers' Research Association at Welwyn, and visited Universities, Research Institutes, Factories, and Rubber Dealers for technical and trade discussions, and in attempts to recruit new staff.

# Annual Report of the Rubber Research Institute of Malaya, 1957

Published contributions to recognised journals were as follows:

|                                                                                                 |   |                                                               |              |
|-------------------------------------------------------------------------------------------------|---|---------------------------------------------------------------|--------------|
| Microflora of Hevea Latex                                                                       | } | <i>Journal of the Rubber<br/>Research Institute of Malaya</i> | D. H. Taysum |
| 1. Growth Media                                                                                 |   |                                                               |              |
| Bacterial Culture Media<br>for Hevea Latex                                                      | } |                                                               | D. H. Taysum |
| A Simple Apparatus for the<br>Collection of Hevea Latex<br>under Aseptic Conditions             |   | <i>Journal of<br/>Applied<br/>Bacteriology</i>                | D. H. Taysum |
| A Review of the Comparative<br>Bacteriology of Hevea<br>Latex and its Commercial<br>Derivatives |   | <i>Applied<br/>Microbiology</i>                               | D. H. Taysum |

Articles published in *Planters' Bulletin* comprised: 'Superior Processing Rubber' and 'Treatment of Skim Rubber'.

In connection with Technically Classified rubber, the following document was prepared and circulated: *T. C. Bulletin No. 36*—World Output of Technically Classified Natural Rubber.

The following internal reports, known as *Chemical Division Reports*, were prepared:

|                                                                                                                   |                                 |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------|
| No. 11—Rubber lignin masterbatches                                                                                | H. M. Edmondson<br>& R. S. Gale |
| No. 12—The problem of latex factory<br>effluents and water pollution<br>in Malaya (A survey report)               | T. V. Molesworth                |
| No. 13—The use of tinopal PCRP to<br>whiten pale crepe                                                            | J. E. Morris                    |
| No. 14—The drying of sheet rubber<br>Part 1. The determination of<br>the water content of raw<br>rubber           | R. S. Gale                      |
| No. 14—The drying of sheet rubber<br>Part 2. An apparatus for the<br>study of the drying rates of<br>sheet rubber | R. S. Gale                      |
| No. 14—The drying of sheet rubber<br>Part 3. The de-watering of<br>rubber coagulum                                | R. S. Gale                      |

The account of work carried out in the Division which follows is presented in four sections: Fundamental Research, Applied Research, Process Evaluation and Advisory Work.



## FUNDAMENTAL RESEARCH

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### Biochemistry

**Aldolase**—Work on the aldolase of fresh latex has now been rounded off, no new developments having appeared. Further experiments confirmed previous observations, that freeze dried serum from high speed centrifuging (C-Serum) has high aldolase activity, and is a cheaper source of the enzyme than the bottom fraction from high-speed centrifuging previously employed in research investigations at Birmingham University. An account of this work has been accepted for publication in *Nature*.

**Fractionation of latex**—One of the major aspects of the biochemical work is concerned with the separation of latex into fractions by centrifugation, the behaviour of the different fractions and the contribution they make to the behaviour of whole latex. Recent studies have been carried out with the 'bottom fraction' which is sedimented from fresh field latex by high speed centrifugation.

Careful preparations in which low temperature conditions were maintained, have emphasised the heterogeneous nature of bottom fraction, which is now known to comprise at least two and possibly four distinct components.

Bottom fraction can be resuspended in solutions of suitable tonicity without undergoing any marked change. After suspension in a hypotonic buffer solution, recentrifugation resulted in a material of different texture, with a much higher water content, which had lost 60% of the original nitrogen. However, on suspension in a hypertonic buffer-manitol solution followed by recentrifugation, the water content of the bottom fraction particles was reduced, and the loss of nitrogen was only 15%.

An interesting observation records that when field latex which has been allowed to stand for some hours is ultracentrifuged, some or all of the bottom fraction is found towards the top of the tube having moved centripetally and not centrifugally as is customary with truly fresh material.

Our present observations thus suggest that in very fresh latex the sedimentable particles are in an unaggregated condition. On high-speed centrifugation under refrigerated conditions, the bottom fraction material is thrown down relatively unaggregated. If low temperature conditions are not maintained, a greater degree of aggregation seems to occur.

On suspension in a hypotonic medium, the particles imbibe water, swell and aggregate with one another and with rubber and Frey-Wyssling particles, if present. Simultaneously they lose much of their nitrogenous material, indicating severe structural damage.

When suspended in a hypertonic medium the particles shrink, lose some water and remain comparatively unaggregated. The loss of nitrogenous matter is much less, indicating considerably less structural damage.

It seems clear that when whole latex is stored at room temperature the sedimentable particles gradually degenerate and aggregate together with rubber particles. If the latex is centrifuged early, the particles are sedimented and carry a small proportion of rubber down with them. At a later stage, the bottom fraction may be aggregated with so much rubber that the 'bottom fraction' is displaced upwards.

**Paper electrophoresis of proteins**—Attention has been concentrated on proteins in aqueous extracts of freeze-dried bottom fraction prepared with latex from four differ-

ent clones, Pil A 44, Gl 1, Tjir I and RRIM 501. Experimental observations are not yet completed, but the following tentative conclusions have been drawn.

Under the conditions of our experiments, two anionic and four cationic constituents are generally observed in bottom fraction. The major anionic component appears to be identical with the material designated Protein C or 'Hevein', which has been isolated by workers at B.R.P.R.A. from R.R.I. freeze-dried serum solids.

The three minor cationic components are all associated with polyphenoloxidase activity; it appears that the enzyme may thus be electrophoretically heterogeneous.

The major cationic protein fluoresces under ultraviolet light and corresponds with that designated Protein A by workers at B.R.P.R.A., where it has been shown to be a nucleoprotein.

Although these six protein constituents are found in all four of the clonal latices examined, there are observable differences between the clones.

Bottom fraction prepared from the latex of clone Pil A 44 showed the six individual components, although differentiation between the three minor cationic ones was not always definite. In a number of cases an extra anionic constituent has been observed. In all cases the aqueous extracts were found to darken rapidly on exposure to air and thus appeared to contain relatively large amounts of polyphenoloxidase substrates. The darkening effect was more pronounced in samples collected from newly opened tapping cuts.

In the case of Glenshiel 1, the aqueous extract of the bottom fraction showed the six normal constituents. There was little darkening, indicating absence of substrates for polyphenoloxidase activity.

With Tjirandji 1, darkening did not normally occur, but was observed in latices obtained from freshly opened tapping cuts, disappearing in later samples collected after tapping had been in progress for some weeks. An additional minor cationic component has been observed in a number of collections, but not in all. This component has so far not been observed in latex from other clones.

In latex collected from RRIM 501, the bottom fraction was found to contain the customary six protein components, and a number of collections have shown an additional anionic member which appears to be the same as that observed in clone Pil A 44. A similar component has also been found in bottom fraction from mixed seedling trees. Little darkening of the extract was observed in extracts of RRIM 501 bottom fraction.

Present indications are therefore, that differences occur between clones in respect of proteins. The method of detecting the component proteins is not, however, a particularly sensitive one and it may be that the differences observed are merely quantitative, certain constituents not being observable when present in insufficient quantity. As far as we know, qualitative differences between the proteins of strains from a given species has not yet been demonstrated for any higher plant by an electrophoretic technique. Further study of this problem would seem to involve a more sensitive analytical procedure.

*Freeze-dried latex fractions*—Supplies of freeze-dried latex fractions to B.R.P.R.A. have continued throughout the year. The preparation of these materials involves special collection of latex, followed by high-speed centrifugation and freeze drying on a comparatively large scale. The work is regarded as of primary importance since the products are indispensable to most of the biochemical research on latex non-rubber constituents in progress in the United Kingdom.

### Microbiology

*Application of bactericides to trees*—Towards the end of 1956, observations made whilst collecting latex under sterile conditions led to the conclusion that the ends of latex vessels exposed by normal tapping cuts were heavily contaminated with bacteria. This apparently led to partial blocking of the latex vessels with consequent impairment of the latex flow.

Experiments were then directed towards applying this discovery to field practice. Tapping cuts were first dressed with aqueous mixtures containing mild alkalis, detergents and strong bactericides or bacteriostatic agents. A positive increase in yield resulted. By applying the aqueous dressing and also injecting the tapping cut with systemic antibiotics (terramycin, aureomycin, dihydrostreptomycin, etc.) much more striking results were obtained. The average yield of seven unselected seedling trees was increased three to four fold. In one case a tree suffering from brown bast and yielding no latex was restored to apparent health and gave excellent yields. In all cases the high yields were maintained throughout the eight months period during which treatment was given.

At this stage attempts were made to design a dressing which could be more simply applied and would withstand the severe conditions of tropical rain. Aqueous dressings were obviously undesirable, and a petroleum jelly base was adopted, incorporating antibiotics, sulphonamides, and a gross fungicidal agent; the composition was coloured by adding malachite green as a means of identifying it in the field, and is usually known as 'vaseline green'.

The result achieved by this treatment alone was to more than double the yield from an area of about one acre of mature unselected seedling trees. The increase in yield has actually been 130% maintained over a period of five months; the high yield continues.

A brief comparison with other yield stimulants carried out on a block of AVROS 50 trees, showed the vaseline green treatment to give the highest yields. In addition, the quality of the latex was improved, concentrates from it showing low VFA and KOH number, and good mechanical stability. Bacterial counts in both field latex and concentrate were considerably reduced.

In another trial on 30 Tjir 1 trees direct comparison of vaseline green applied once in six months and 2,4,5-T applied at three monthly intervals showed comparable yields, but precoagulation was distinctly less for the vaseline green treatment.

Combinations of 2,4,5-T and bactericidal treatments have also been studied over a period of seven months on two acres of mixed clonal seedlings. The introduction of bactericides into the normal 2,4,5-T dressing gave a definite increase over the 2,4,5-T treated control. The addition of 2,4,5-T to vaseline green likewise gave enhanced increases in yield. The effect of adding different levels of 2,4,5-T to vaseline green is still being studied but it is interesting to note that whereas at a level of 0.3% 2,4,5-T had little effect on its own, in the presence of bactericides a significant increase in yield was obtained.

The observation that application of bactericides to the tapping cut increases the flow of latex from the tree is now well established. The commercial significance of the work however remains to be evaluated.

The implications of these observations are worth considering, particularly the reason why such marked increases in yield are obtained following injection of the tapping cut. Apart from reducing bacterial infection and thus cleaning the latex vessels so that uninterrupted flow of latex can occur, the possibility of rendering the tree more vigorous by freeing it of the need to cope with a heavy infection should be considered. It is



interesting to speculate whether this could result in a higher proportion of metabolic energy being free for rubber synthesis without detriment to the tree itself. Further facts which have a bearing on these views are afforded by observations recorded below on agglutination reactions.

*Agglutination reactions*—It has been established that the degree of contamination of the latex vessels is high in routine tapping operations on all trees examined so far; these comprise mature mixed clonal seedlings, mature unselected seedlings, mature Tjir 1 clonal buddings, mature AVROS 50 clonal buddings, young PR 107 clonal buddings (15 months after opening) and mature Glenshiel 1 clonal buddings and seedlings. Since the indigenous bacterial population is so high it is interesting to consider why the attack proceeds no further along the latex vessels than the few tenths of an inch observed. The possibility of an agglutination mechanism transported by the latex itself was considered.

Latices were collected from previously unopened trees and from trees in normal tapping, which were of course markedly contaminated, and experiments made with latex and with latex sera prepared by high-speed centrifugation and filtration. Definite agglutination reactions were observed, being strong and well defined in the case of sera, whereas those obtained with the hydrocarbon particles were definite but weak. Unopened trees showed strong and rapid agglutination with filter sterilised sera from a wide variety of normal tapped trees, suggesting that in the vicinity of the tapping cut at least, the latex undergoes a modification as a result of tapping (wound response) or bacterial infection or both. These observations are of a preliminary nature but they open up new possibilities for further investigation and it is important to confirm and extend them.

*Bacterial counts*—The technique for viable counts has been widely employed both for field latex and for latex concentrates, and has proved a most valuable tool for dealing with problems arising in latex production and shipment.

The question of total counts has now been studied; this represents the total bacterial cells present, both dead and viable. A technique has been devised which appears satisfactory and consists in isotonic dilution, high-speed centrifugation and counting by dark ground microscopy employing a phase contrast system. The operation is thus not simple and at present imposes considerable limits on the number of samples which can be examined.

It has been shown that all latex at the time of collection is grossly contaminated with bacteria; counts up to  $1 \times 10^{10}$  cells per ml are normally found. With ammoniated latex concentrates, the count is about one order lower and ranges from  $1 \times 10^8$  to  $1 \times 10^9$ . It is now apparent that all such latices must demonstrate the possibility of considerable enzymic activity, derivable from both living and dead bacteria.

*Latex microscopy*—An examination of field and concentrated latex using the phase contrast microscope has indicated a number of different particles existing in latex. These observations confirm and extend those of earlier workers but require to be established more firmly before any definite conclusions can be drawn.

### *Polymer Chemistry*

Earlier work has shown that the formation of peroxide groups is responsible for bad ageing of rubber in latex, particularly if it has been agitated in the presence of air or purified. It has also been shown that such peroxidic groups are capable of initiating the polymerisation of certain monomers, such as methyl methacrylate, in the presence of a reducing system. Further work with aerated latices has confirmed these observations.

It is found that the reactivity of aerated latices is confined to the rubber phase, sera prepared by creaming and centrifuging showing no activity. On storing in absence of air the reactivity slowly disappears and is accompanied by an increase in the degree of cross-linking of the rubber hydrocarbon.

For activating the peroxide groups as polymerisation initiators, polyamines and other reducing systems such as EDTA, hydrazine sulphate and ferrous sulphate, pyrophosphate, glucose and ferrous sulphate, etc. have been found effective. In the presence of such systems, all the vinyl monomers examined, with the exception of acrylic acid, polymerised readily; the monomers included methyl methacrylate, n-butyl methacrylate, ethyl acrylate, acrylonitrile, styrene and methacrylic acid.

Rubber-methyl methacrylate graft latices prepared with these activated latices showed good film forming characteristics and recent reports from B.R.P.R.A. have confirmed our observation that, in the case of latex samples prepared according to this method, for a given per cent of monomer addition a definitely higher wet gel strength is obtained when the graft is formed from aerated latex as compared with unactivated latex. Higher yields of graft polymer were also obtained with aerated latices.

Aerated latices in which grafts have already been formed, can be reactivated by a second period of aeration to undergo further graft polymerisation; this opens up the possibility of increasing the number and length of side chains of secondary polymer and so modifying the molecular configuration of the copolymer.

Since amines are suitable reducing systems for activation of the peroxides, members of this group naturally occurring in latex, would be expected to function in the same way. This is found to be so, and aerated fresh latex shows positive polymerisation activity without the addition of a reducing system. The naturally occurring amines which function in this way appear to be water soluble and are confined to the aqueous phase. They can be precipitated with oxalic acid, when they cease to behave as peroxide activators.

An interesting observation made during the course of this work is that polyamines are powerful antioxidants for raw rubber, whether the latter has been activated by aeration of the latex or not. This is thought to be associated with their known tendency to promote cross-linking rather than chain scission in the presence of hydroperoxy free radicals.

### *Drying Of Coagulum*

Preparatory work for this programme has demonstrated some interesting points. It has been shown that the moisture content of rubber can be reduced to well below 0.1% by bringing to equilibrium over activated alumina containing less than 5% water, the dry weight of rubber being defined as the weight obtained after vacuum drying at 0.01 mm mercury at 50°C. On heating such sheets in an oven at 93°C (200°F), however, a further loss of approximately 0.4% occurs. It is thought that this loss may be partly accounted for by volatile matter other than water.

In the early stages of de-watering, serum exudes from coagulum by syneresis, the rate of exudation being very sensitive to any small compressive stresses imposed, as for instance by the weight of the coagulum itself. The rate of exudation of serum is also greatly influenced by the history of the latex before coagulation, the presence of additives, e.g. anticoagulants, and the pH of coagulation.

Machining reduces the moisture content of coagulum to a much lower level, but it is doubtful whether less than 15% water can be achieved by this means. Machined sheets also lose water in an atmosphere of 100% relative humidity by exudation, the

rate being materially affected by temperature; thus lightly machined sheets with a serum content of 150% and normally machined sheets with a serum content of 40% both lose about half their serum in 48 hours at 30°C or in 10 hours at 60°C.

The major study of temperature, humidity and rate of air flow upon the drying of coagulum has not yet been completed. Earlier work demonstrated the relative unimportance of rate of air flow and the main experiment now in hand is a factorial one, investigating four levels of temperature and four levels of humidity.

Major conclusions will have to await completion of the statistically designed block experiment, when the data can be analysed. One definite interim conclusion is, however, that increasing the relative humidity of the drying air slows down the drying even during the later stages when diffusion through the rubber is a controlling factor. An increase in relative humidity from 25 to 55% increases the total drying time by some 50%.

This result is of considerable practical importance since it could explain much of the variability in performance of many commercial drying sheds. It also indicates two opposing cost factors in the design of a drier to operate for a given rate of throughput of rubber at a given temperature. Use of higher humidities would require less ventilation and thus save cost in heating air. On the other hand more space would be required, with a consequent greater expenditure of heat to offset heat losses.

Attempts have been made to interpret the drying rate data for the diffusion controlled stages. The relationship between drying rate and water content is not that which would be predicted by the classical diffusion equations, using concentration as the driving force term. A better prediction is obtained by using vapour pressure as the operative force; even so the observed effects can only be explained qualitatively. It appears likely that a more comprehensive analysis will have to be carried out before quantitative explanations are obtainable, since there is at present no analytical solution to the diffusion equations in cases like rubber where the vapour pressure isotherm is non-linear, and numerical trial and error methods have to be employed.

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## APPLIED RESEARCH

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### LATEX TECHNOLOGY

#### *Bacterial Control in Factories*

The importance of good hygiene in factories where latex concentrate is being prepared has been demonstrated many times. But even in a well run factory, sporadic outbreaks of bacterial infection are not always avoidable. The question of factory cleansing has therefore been under active consideration and the findings of a series of statistically planned trials which were continued over a period of four months are worth considering.

The trials were made at the Experiment Station Factory, Sungei Buloh, and were aimed at establishing three types of factory conditions. The first approximated to common factory practice, the centrifuges, reception tank, and utensils being washed every day, the field latex pipelines rinsed daily and thoroughly cleaned every fourth day. Concentrate tanks were also washed every fourth day, after removal of the bulked latex.



In the second set of conditions, very thorough washing of all plant and utensils was carried out every day, using copious supplies of water.

In the third series, the thorough washing was followed by rinsing with bactericidal/detergent solutions, the composition of which was changed every few days to avoid the development of resistant strains of bacteria.

Analysis of the data indicated a significant difference between the first method of cleansing and the others, which were much more thorough. The content of viable bacteria in the final latex concentrate was considerably reduced by thorough washing. For part of the experiment, further improvement was obtained by employing bactericidal washes.

Although no statistically significant differences in the technological properties of the concentrates were observed up to three months after preparation, the fact that a reduction in bacterial count was obtained is sufficient recommendation for the adoption of more thorough cleansing procedures. The practical advantage of utilising a series of bactericidal rinses in addition to thorough water washing lies in reducing the risk of sporadic outbreaks of infection, and subsequent deterioration of the latex during shipment and storage.

Whilst recommendations in respect of factory cleansing must to some extent be specific to each factory, there is no doubt that systematic application of thorough water washing daily is very important for all factories. The use of bactericidal rinses is rather a matter for application in those instances where the need has become apparent.

An interesting series of observations were made possible on shipments of commercially prepared concentrate by the cooperation and courtesy of certain latex producers and their customers. Samples were taken at many stages of the journey from producing factory to consuming factory. Bacterial examination permitted comparison between cleansing systems adopted in different factories and also indicated the sources of infection liable to be encountered during transport. By far the most important of these were rail tank cars, in respect of which it is obviously important to organise very thorough cleansing, as with all other plant used to house or convey latex, if quality is to be maintained. In general, storage tanks at port installations and ship's bulk tanks were found not to be sources of serious contamination.

### *Latex Preservation*

During the year commercial interest in the new low ammonia latices has steadily increased and amongst those shipped in bulk for commercial use, latex preserved with boric acid according to the R.R.I. process has proved promising.

Although on the whole satisfactory, it has been reported to us that boric acid concentrates share with some other low ammonia concentrates two weaknesses. The first is poor ageing of raw rubber films prepared with the latex, the second is the sporadic onset of bacterial contamination, leading to high KOH number; the VFA number is usually unaffected and remains low.

The first of these problems does not appear to be of major importance for boric acid latex, since the ageing of vulcanised films, foams and so on, appears to be normal. The poor ageing characteristics of the raw film is also not always apparent in boric acid latices since we have prepared and shipped small quantities to the U.K. which show no adverse behaviour. The problem thus appears to be an elusive one which occurs on occasions. Work is in hand which aims at providing a solution.

The second problem appears to be more serious and suggests that the boric acid system as originally propounded, is not sufficiently powerful to cope with all bacterial contamination that occurs. This has been confirmed by repeated preparations at weekly intervals under standard commercial conditions at the Experiment Station. Many preparations showed low viable counts (less than 10 per ml) which still remain in good condition some months after preparation; others showed high counts ( $1 \times 10^3$  to  $1 \times 10^6$  per ml), indicating inadequate bactericidal conditions.

Means of increasing resistance to infection have been studied and a number of alternative substances appear to be effective under laboratory conditions. These include selenium dimethyl dithiocarbamate, zinc oxide, formaldehyde, neomycin, mercapto-benzthiazole, its zinc salt, and other accelerators of vulcanisation. These materials have been found effective when added to low ammonia-boric acid latices at reasonably low concentrations. Further trials are in hand, from which it is hoped to select the most suitable systems for small scale shipment and consumer evaluation.

#### *Other New Preservative Systems*

Recent work on preservation of latex has confirmed the value of zinc oxide as an enzyme poisoner/bactericide in low ammonia systems. It is understood, however, that latex users do not like the addition of zinc oxide to concentrate in any quantity since it may give rise to variable or excessive viscosity on storage or during subsequent processing. Another peculiarity is that zinc oxide in amounts ranging from 0.02 to 0.2%, when added to 0.7% ammoniated latex concentrate, causes poor ageing of the raw rubber film. After storing the concentrate for two or three months, however, the ageing characteristics of the rubber are much improved, and often approach normal behaviour. In no instances have we found poor ageing of vulcanised rubber prepared from these latices.

In spite of these drawbacks, it is thought possible that zinc oxide may find application as a preservative for low ammonia latices since it is cheap and very effective at low concentrations. As it often forms one of the vulcanising ingredients subsequently added to latex, its presence cannot be regarded as harmful.

A number of systems employing zinc oxide have now been examined and samples of the more promising ones have been sent to the U.K. for evaluation by our colleagues at Welwyn. Systems which are considered to be worthy of further investigation include selenium dimethyl dithiocarbamate 0.01 with zinc oxide 0.02, organic accelerators (e.g. M.B.T., Santocure) 0.05 with zinc oxide 0.05, combinations of antibiotics with zinc oxide and of sulphonamides with zinc oxide. The figures given represent parts per cent latex concentrate and have been employed with ammonia 0.2 and lauric acid 0.03 to 0.05.

Another system which is still promising is ammonia 0.2 with selenium dimethyl dithiocarbamate 0.05 and lauric acid 0.05. Trials with tetrachloro m-cresol have also been successful, using 0.3 to 0.4 parts with ammonia 0.2. Here again zinc oxide is effective and at a level of 0.05 parts only 0.05 parts tetrachloro m-cresol was found necessary for good preservation in our experimental trials.

The above systems are still being examined; some may later prove worth while investigating at commercial level. In some cases the reagents are likely to be too costly, in others the availability in commercial quantities is not yet assured.

#### *Foam Rubber*

Work on establishing tests for the suitability of latex concentrates for foam rubber production has continued. We are now equipped to carry out the full range of tests recommended by the British Latex Foam Manufacturers' Association.

A preliminary survey of commercial Malayan concentrates from different sources showed that whilst satisfactory foam could be made with each sample, one standard formula could not be utilised for all the latices; differences between the concentrates were sufficiently marked in some instances to necessitate modifications in the formulation before satisfactory foams could be produced. No correlation was established between quality of foam and composition shown by chemical analysis. The latices were tested immediately upon receipt and again at intervals of 3 and 6 months after preparation. In all cases the samples stored for 6 months gave the best results. In other experiments artificial ageing for 20 hours at 80°C gave improved foam production; the addition of amines, for instance aniline, had a more marked effect in improving foam-making behaviour of freshly prepared concentrates.

It is of interest to record that aeration of freshly made latex concentrates with a view to increasing mechanical stability, had no observable effect upon behaviour during foam making.

#### RUBBER TECHNOLOGY

During most of the year the post of Rubber Technologist was vacant and the section was supervised by the Officer for Technically Classified Rubber. In consequence, few investigations were undertaken and the staff were largely occupied in routine testing.

##### *Control of Vulcanising Characteristics*

Further experimental work has confirmed earlier findings that small amounts of formaldehyde added to latex before coagulation considerably modify the vulcanisation characteristics of the sheet obtained. An increase in strain value of 15–20% has been induced, which is sufficient to shift technical classification from the blue to the yellow class.

Preliminary experiments carried out in cooperation with the Colloid Section in connection with a continuous process for preparing dry rubber, has confirmed earlier observations on the importance of naturally occurring basic constituents of sheet in controlling vulcanisation characteristics. Present experiments have followed the changes in basic constituents ('amine value') during coagulation, machining and dripping of the sheet. It is found that the 'amine value' is reduced by 50% during coagulation and by a smaller amount during machining and dripping. The constituents responsible for modifying vulcanisation behaviour, e.g. strain value, are water soluble and are thus found in the serum. They react rapidly with formaldehyde and this reaction is probably responsible for the increase in strain value found when latex is treated with formaldehyde.

There is some evidence both of formation, and of disappearance of basic constituents during storage of wet coagulum and sheets. This is not fully understood and further studies are in hand.

It appears possible that this work could lead to a means of controlling the modulus of rubber so that a product of reasonably uniform vulcanising characteristics is obtained. It is proposed to investigate means of applying this to normal estate production as well as to continuous methods of preparation.

##### *Superior Processing Rubbers*

Attempts to reduce the cost of preparing superior processing (SP) rubber have resulted in a modified formula for vulcanisation of the latex. This employs zinc diethyldithiocarbamate in place of the sodium salt, and thus permits reduction in the amount



of zinc oxide required. A simplification in the dispersing system employed for the vulcanising ingredients has also been successful. Commercial production now employs the new formulation.

Methods of conferring SP characteristics on lower grade rubbers have been studied further and the possibility of employing a masterbatch has been demonstrated.

Masterbatches can easily be prepared containing 90 parts of vulcanised to 10 parts of unvulcanised rubber. By mixing the required proportion with a lower grade stock, rubbers having excellent SP characteristics can be obtained. This can be achieved in two ways. The first employs the masterbatch in the form of a fresh crumb coagulum, which is mixed with scrap and lump to give remilled crepe. Trials in a remilling factory gave satisfactory results with an 80% masterbatch, higher concentrations being difficult to handle and resulting in brittle crepes. The second process utilises the masterbatch at the 90% level as a dry crumb and mills it into the lower grade stock on the normal mixing mill or banbury mixer. The operation can with advantage be carried out by the manufacturer himself. This method of operation requires shipping the masterbatch to consuming countries and thus entails two further problems, packing and customs duty.

As normally prepared the crumb has a low bulk density and is difficult to compress into a small bulk. Trials in which the crumb was machined on a dry creping mill showed that a coherent crepe was obtained by making one pass only. A small shipment of masterbatch crepe prepared in this way and packed in paper bags has been made; the results of trials in the U.K. are awaited.

A difficulty may arise in shipping SP masterbatch to those consuming territories where a customs duty is imposed on vulcanised rubber imports, since 90% of the material is vulcanised.

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## PROCESS EVALUATION

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### *Effluent Disposal*

During the past few years it has become apparent that disposal of effluent from latex concentrate factories is a growing problem. Serious pollution of water courses has occurred and there is an obvious need for suitable means of disposal to be available for application when the need arises.

Although recognised methods for effluent disposal are well established in other territories, little attention had been given to the problem of effluent from rubber factories in Malaya. As a first step a questionnaire was sent to all latex concentrate producing factories, in order to obtain information about effluent volumes, water usage and the like. It was not possible from the information received to estimate the extent of pollution, but subsequent investigations have indicated that pollution is heavy in those cases where it does occur.

It is now proposed to build an experimental full scale plant for treating effluent at the Experiment Station and to determine its operating characteristics under different conditions. A trickling filter plant has been selected since it is technically simple, is stable under a wide range of conditions and has comparatively low operating costs. Treatment of the aqueous effluent will be preceded by a preliminary settling tank, filter and sump for removing the bulk of the rubber and other solids, followed by a flocculating and settling tank for removal of suspended material by the use of coagulants.

### *Sterilisation of Latex*

It has been found possible to reduce the count of viable bacteria in ammoniated latex by over 95% by irradiating with ultra-violet light. The time required to kill the bacteria is dependant upon the thickness of the layer of latex exposed. Preliminary experiments only have been carried out, the most promising results being obtained by rotating a cylinder about a source of u.v. light and allowing a film of latex to form on the inside wall. The objective of this work was to determine what degree of kill could be obtained under conditions likely to be applicable industrially and what would be the cost of the operation.

The capital outlay involved does not appear to be excessive although the plant would be cumbersome. Operating costs would probably be high due to the relatively short life of the u.v. tubes employed. It is estimated that the total cost for treating latex concentrate including depreciation of plant would be about one cent per pound of rubber. Although the degree of bacterial kill obtained would be valuable as a means of improving preservation, the cost as estimated is excessive. The project thus appears unpromising unless a much cheaper source of u.v. light can be obtained.

The use of ultrasonic irradiation has also been examined as a means of sterilising latex. Trials with a low frequency generator (20 kilocycles) showed very little effect upon ammoniated latex concentrate. Under the conditions employed, there was some evidence for a change in the type of bacterial population, but no evidence of a substantial kill. It is of interest to record that filtering of latex through a sintered glass plate was speeded up by the application of ultrasonic vibration. Breakdown of rubber solutions in benzene as shown by decreased viscosity was found to be accelerated unless oxygen was rigidly excluded.

### *Thiol Acid Rubbers*

During recent years a special rubber has been developed at B.R.P.R.A. which retains its flexibility at low temperatures. The process is not fully understood but is thought to consist essentially of attaching groups at random to the rubber hydrocarbon chain, thus hindering crystallisation. The group employed for this purpose is thiol-benzoic acid which adds on at a double bond.

The preparation of thiol-benzoic acid rubber employs latex, which unfortunately contains a naturally occurring inhibitor of the addition reaction. It thus becomes necessary to use latex purified by twice centrifuging, which renders the process costly.

Attempts have now been made at R.R.I. to produce thiol-acid rubber in Malaya more cheaply than in the U.K. Under conditions obtaining here, we have found it possible to modify the coagulation stage of the process and can now utilise a cheaper system. A 40 lb batch of this material has been forwarded to Welwyn for examination. The material is somewhat soft, and attempts are being made to overcome this difficulty.

Steps are also being taken to examine the inhibitors present in field latex. If these can conveniently be removed or rendered ineffective by a simple chemical change, the need to use doubly centrifuged concentrate for preparing thiol-acid rubber may be avoided, resulting in a much cheaper product.

### *Superior Processing Rubber*

Considerable interest has been shown in superior processing (SP) rubber. During the year we prepared 135 tons SP rubber as RSS 1 and 27 tons as ADS. Commercial production of SP sheet amounted to 119 tons and of SP crepe 72 tons. The total production for industrial consumption was thus 353 tons.

Samples of all commercial production were forwarded to R.R.I. for quality control tests.

One enquiry for purified crepe having SP characteristics was received. A small parcel was prepared and despatched; we now await reports upon the material.

### *Cyclised Rubber*

Total commercial production in Malaya amounted to a little over 140 tons during 1957. R.R.I. continued to carry out quality control checks on all production lots.

### *Skim Rubber*

An experiment carried out at the Experiment Station demonstrated that on converting skim latex into dry rubber the yield obtained by preparing sheet was 4 to 5% greater than that obtained by preparing crepe.

### *Rubber Lignin Masterbatch*

The investigation on rubber lignin masterbatch has been brought to a close. Final assessment of the situation indicated that large scale preparation of the material could be operated satisfactorily and a product obtained having characteristics which would be of value to the consuming industry. The material, however, did not possess the unique properties promised in early small scale experiments and the characteristics of the final vulcanised product could be equalled by alternative methods of compounding already established in practice. Since the cost of the lignin materials was approximately the same or even higher than that for the existing processes, no advantage was likely to be gained by pursuing the project further.

It may be worth while reviewing the situation should a substantially cheaper source of lignin become available.

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## ADVISORY

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The Advisory Officer, Mr Morris, returned from leave in February, and took over the duties of the Analytical Section as well as the Advisory Service of the Division. In spite of these double duties, the volume of advisory work handled has expanded, as shown by the following records:

|                          | <i>Letters<br/>received</i> |              | <i>Letters<br/>despatched</i> |              |
|--------------------------|-----------------------------|--------------|-------------------------------|--------------|
|                          | 1956                        | 1957         | 1956                          | 1957         |
| <i>Correspondence</i>    |                             |              |                               |              |
| Sheet production         | 247                         | 262          | 289                           | 328          |
| Crepe rubber production  | 324                         | 357          | 396                           | 412          |
| Latex production         | 758                         | 849          | 1,066                         | 1,330        |
| Other processes          | 140                         | 287          | 169                           | 428          |
| Classification of rubber | 1,619                       | 1,307        | 965                           | 659          |
| Research and others      | 454                         | 605          | 589                           | 809          |
|                          | <u>3,542</u>                | <u>3,667</u> | <u>3,474</u>                  | <u>3,966</u> |



| Visits                             | 1956 | 1957 |
|------------------------------------|------|------|
| Advisory                           | 94   | 183  |
| Experiment station                 | 433  | 561  |
| Research and others                | 20   | 44   |
| Interviews                         | 329  | 298  |
| Lectures to Planters' Associations | 2    | 2    |

*Samples examined*

|                             |        |        |
|-----------------------------|--------|--------|
| Latex hydrometers           | 141    | 73     |
| Customs' samples for d.r.c. | 510    | 455    |
| Latex samples               | 1,275  | 1,223  |
| Sodium bisulphite           | 4      | 2      |
| Coagulants                  | 11     | 2      |
| Defects in sheet and crepe  | 169    | 244    |
| Cyclised rubber             | 159    | 259    |
| SP rubber                   | 77     | 228    |
| T.C.R.                      | 24,368 | 21,280 |
| Others                      | 188    | 233    |

*Sheet Rubber.*

With increased crops from high yielding rubber now coming into bearing, and the drop in latex concentrate production early in the year, many estates have been interested in improving and extending their factory facilities for making sheet. This has applied particularly to smokehouses, and many estates have replanned existing houses and built new ones.

In view of its greater flexibility, particularly regarding possible conversion to air drying, the tunnel type smokehouse has been preferred to the Subur type. Besides this, the latter often gives rise to condensation problems, tar dripping on sheet for instance, and is not so easy to operate for control of temperature. On sites having a high water table, it is now recommended that normal R.R.I. types are built, raising the floor some two to three feet, so that the bottom of the furnace is at ground level. Approach to the smokehouse is by ramps placed one at each end. This system has been found to work satisfactorily, and in some cases gives quicker drying than similar houses with the floor at ground level.

Much interest has been shown in the oil fired forced draught drying shed (G.E.C. type and others) and approximately 40 have now been erected throughout the country. We have observed that operation for ADS, pale crepe, estate browns and skim blanket has been quite satisfactory. A considerable amount of time has been spent in discussing and advising on the organisation of drying procedures on estates.

The perennial problem of fermentation bubbles was again dealt with successfully using formaldehyde, formaldehyde with sodium sulphite, or in very bad cases, ammonia. Precoagulation and subsidiary defects were found to be most prevalent with Glenshiel 1 latex.

Occasional reports have been received of weak sheet, usually occurring in rubber from young clonal trees, particularly RRIM 501, PR 107 and Gl 1. Admixture with latex from more normal sources has been found a ready means of eliminating the trouble; inclusion of not more than 20% of the weak rubber is recommended. As far as we can ascertain, the properties of such rubbers after vulcanising fall within the normal range. It is recommended that sheets prepared solely from these clones should not be used for wrapping bales.

### *Crepe Rubber*

The use of R.R.I. bleaching system, Emulsion A concentrate, is still quite extensive and distribution during the last six months of 1957 was sufficient to deal with more than twice the average Malayan output of pale crepe if used at the recommended level. Many estates have been advised on the quantity of bleaching agent to employ, following individual experiments with their own crop. Excessive dosage with Emulsion A should be avoided as it not only softens the crepe, but may aggravate subsequent discolouration.

The use of oxalic acid as a coagulant has also been examined and found to be successful in some instances in preventing discolouration on storage.

A possible source of poor colour is the use of totally enclosed systems in oil-fired and other drying sheds. If wet crepe is treated in such a manner, it sometimes develops stickiness which is often associated with a slight darkening in colour. It is recommended that total enclosure is avoided during the early stages of drying and intake of a small amount of fresh air is permitted.

Other problems which have been discussed include plying of sole crepe, fungal contamination and hardness.

### *Latex Concentrate*

Latex concentrate production proceeded with increasing momentum throughout the year, and by the close, most large producers were producing to capacity. Production during 1957 was just short of the record and amounted to nearly one sixth of Malayan rubber output.

Many estates have been advised on the setting up of their own testing facilities, particularly for d.r.c. determination, and frequent demonstrations of latex test procedures given to factory clerks.

Advice on maintaining cleanliness in latex concentrate factories has often been given. Once attention is directed to avoiding major sources of contamination, the less obvious ones are often revealed and prove very important in controlling quality of the final product. The need for persistent attention and care becomes more and more apparent. The value of viable bacterial counts as a diagnostic tool has been amply confirmed.

There has been an inclination to increase the use of additives to normal ammoniated latex in an effort to overcome the defects produced by poor field hygiene. Santobrite and formalin have been the most popular secondary preservatives, but phosphates and other preservatives associated with 'low ammonia' latices have also been employed. This practice has the disadvantage of introducing further reagents into the latex and still leaves the latter with a high content of dead bacterial cells, which may give rise to deleterious changes by enzyme activity. The value of establishing good hygiene in both field and factory cannot be over-emphasised.

A marked interest in low ammonia latices has developed during the year. Commercial production has been mainly concerned with Santobrite type latices, whilst boric acid and Z.D.C., all of which were first developed at R.R.I., have also been shipped in considerable quantities.

A considerable number of consumer complaints against Malayan produced latex have been investigated. In most instances the trouble lay with the user, who did not sufficiently appreciate the need for care and cleanliness in handling latex concentrate and the ways in which variability of natural rubber latex can be countered in his factory.

*Skim Rubber*

Some estates have demonstrated that small amounts of skim rubber can be incorporated into brown crepe with no apparent disadvantage. The colour of the brown crepe is improved, particularly if care is taken to render the mixture homogeneous, as for example, by blending in a scrap washer. Although this practice is contrary to that called for by the International Type Descriptions, it appears to be a convenient and harmless method of disposing of skim coagulum, provided the amount added to the brown crepe is strictly limited to a fixed amount as judged by control tests. In view of the present specifications, however, such a procedure cannot be recommended for normal market grades. This does not, of course, preclude the possibility of selling such rubber by sample.

Little interest has been shown in preparing improved rubbers from latex skim, largely because of the much lower yield of marketable material obtained, high processing costs, and inability to dispose of the product at a profit.

*Technically Classified Rubber*

The number of estates participating in the scheme for technical classification has decreased from 100 in January to 88 in December, with a consequent drop in the total amount of rubber classified, which is estimated at 25,639 tons as compared with 30,070 tons in 1956. Details of estate production are given below:

ESTIMATED OUTPUT OF RUBBER FROM ESTATES USING R.R.I. FACILITIES  
FOR TECHNICAL TESTING TOGETHER WITH SOCFIN PRODUCTION\*

| Type<br>of<br>rubber | Technical classification |                  |                |        |
|----------------------|--------------------------|------------------|----------------|--------|
|                      | In long tons             |                  |                |        |
|                      | Red<br>Circle            | Yellow<br>Circle | Blue<br>Circle | Total  |
| RSS 1                | 295                      | 18,897           | 5,288          | 24,480 |
| RSS 2                | —                        | 522              | —              | 522    |
| Compo                | —                        | 81               | —              | 81     |
| Pale crepe           | 442                      | 44               | —              | 486    |
| Clippings            | —                        | 70               | —              | 70     |
| ADS                  | 819                      | 715              | 63             | 1,597  |
| Total                | 1,556                    | 20,329           | 5,351          | 27,236 |

\* Socfin production was exclusively 1,597 tons ADS

Production from packing houses is a little higher than for the previous year, the totals being 765 tons in 1957 as compared with 669.5 tons for 1956. The demand for classification has varied considerably from month to month, ranging from a minimum of 15 tons in October to a maximum of 124 tons in November. Details of packing house production are as follows:



## RUBBER FROM PACKING HOUSES CLASSIFIED AT R.R.I.

| Type of rubber | Technical classification |               |             |       |
|----------------|--------------------------|---------------|-------------|-------|
|                | In long tons             |               |             |       |
|                | Red Circle               | Yellow Circle | Blue Circle | Total |
| RSS 1          | 36.0                     | 391.5         | 217.2       | 644.7 |
| RSS 3          | —                        | —             | 60.0        | 60.0  |
| Compo crepe    | 5.0                      | 25.0          | —           | 30.0  |
| ADS            | 25.3                     | 5.0           | —           | 30.3  |
| <i>Total</i>   | 66.3                     | 421.5         | 277.2       | 765.0 |

Remilling factories have shown no interest in classification so the estimated total 1957 production resulting from R.R.I. classification is 26,404 tons. To this should be added the output from the Socfin Company, which was 1,597 tons, bringing the Malayan total to 28,001 tons.

Classification test procedure has continued unchanged, but on some estates classification has become difficult because of wide day to day fluctuations in vulcanisation behaviour. In such cases classification by lot, (normally used for packing house rubber), has been inaugurated and is working well.

In respect of consumers requirements, Yellow Circle class rubber (medium vulcanisation characteristics) continues to be the most popular form of Malayan T.C. rubber. There appears to be no demand for Red Circle rubber. Blue Circle rubber usually finds a market, but one estate withdrew recently because its rubber all fell in the Blue class and was difficult to dispose of.

The Division has continued to act as technical coordinator for the International Rubber Research Board (I.R.R.B.) in respect of the international aspects of the T.C.R. scheme. Laboratory cross-checks with T.C. test stations in other producing territories have been carried out at regular intervals, and reports on world production of T.C. rubber prepared and forwarded to I.R.R.B.

W. G. WREN  
Head of Chemical Division

## *Smallholders' Advisory Service*

Mr L. R. Davidson, Inche Shamsuddin bin Yub Ahmad and Mr J. G. Samuel were on duty throughout the year. Mr J. M. F. Greenwood left for England on long leave on 22 April and returned to Malaya on 29 November after having undertaken a tour of visits with officers of the Ceylon Smallholders' Advisory Service from 18 to 27 November.

Inche Mohd Johar bin Mohd Rashid in Kelantan and Mr Wong Mun Yun in Negri Sembilan and Malacca continued to supervise the work of Rubber Instructors and Junior Rubber Instructors in their areas throughout the year. In Malacca the building of hostel and quarters at the pilot training school for smallholders and the initiation of training was a major undertaking. In Kelantan extensive training in budgrafting was organised in new planting areas and a formal course of instruction on rubber growing and production was provided for smallholders at Machang.

Two Rubber Instructors were on leave for four months and three months respectively. Three Chinese Rubber Instructors resigned during the first half of the year. Two accepted appointments in large estate organisations and one with a commercial firm. One Malay Rubber Instructor resigned with effect from 1 June in order to take up an appointment with the Rubber Industry (Replanting) Board and another tendered his resignation to be effective from the end of the year for the same purpose. Two Rubber Instructors were required to transfer stations in order to minimise effects of staff losses but unfortunately one had to be admitted to hospital for prolonged treatment immediately after transfer and was still in hospital at the end of the year. No R.R.I. scholars were available for recruitment from the College of Agriculture because no scholarships were provided in 1954. A private student who completed his diploma in 1956 was appointed on probation from 21 October. Our strength of fully qualified Rubber Instructors (including Senior Rubber Instructors) was thus again reduced from 26 to 22.

In 1957 it proved possible for the College of Agriculture to accept three entries provided for by R.R.I. scholarships. Candidates were of a high standard and more numerous than in previous years; thirtysix were interviewed and the scholarships awarded to a Chinese Junior Rubber Instructor, a Malay school teacher and a Malay student. These were accepted by the Principal of the College for entry to the first year of the diploma course in June.

Two Chinese and one Malay Junior Rubber Instructor resigned during the year and one was dismissed. In recruiting new Junior Rubber Instructors it was decided to alter the preliminary training course from the first quarter of the year to August when more complete representation of seasonal work could be assured. Over 400 applications were received for appointment as Junior Rubber Instructor and over 200 were interviewed in their own States. Final selection was made from 38 candidates interviewed in Kuala Lumpur and seven Malays and five Chinese were selected for the training course. The general educational standards and vocational aptitude appeared higher than in previous selections and all were appointed on three months' probation with effect from 1 November. At the end of the year we had 39 Junior Rubber Instructors of whom two have entered the College of Agriculture with R.R.I. scholarships. The cadre of Rubber Demonstrators remained at nine throughout the year.

General staff shortages at the Institute in 1957 made it undesirable to initiate new building of houses for Rubber Instructors after the first quarter. Work put in hand in 1956 resulted in completion during the year of houses at Batu Pahat (2), Muar (1) and Ipoh (1). The Junior Rubber Instructor's house at Dabong was built. Building at Taiping was delayed by difficulty in getting necessary provisions made through the cooperative development society and Town Council for access road and water supply.

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## ADVISORY

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### *Tapping*

Young areas on smallholdings reaching maturity have not yet become extensive but the limited numbers have indicated that errors of premature tapping, direction of cut and frequency of tapping require special attention and will become a major task as replantings and new plantings progress.

### *Manufacture*

Study of the figures of smallholders' latex collected for sheet production in central factories or for concentration indicates the marked effect of staff losses and incidence of leave on our figures. The details for 1957 are not therefore quoted but by interpolation it can be judged that latex collection from smallholders has remained at about the same level as in 1956, about 5,500 tons of dry rubber used approximately equally for sheet and concentrate production.

It is apparent that extension of central processing for smallholders' rubber requires either much greater efficiency and economy in the organisation of collection and transport of latex or the development of improved means of preserving latex on the smallholding so that frequency of collection can be reduced.

In the first half of the year plans were made in collaboration with Mr H. A. Fell, Registrar of Statistics, for a survey of the predominantly Chinese factories which provide facilities for smallholders to process their rubber, and smoke the sheet for the smallholders. The product of these 'do-it-yourself' factories is thought to be generally of higher quality than the average production of smallholdings and the methods of operation and the grades of rubber produced deserve systematic study as a possible means of improving the general quality of smallholders' rubber. Our plans had to be abandoned, because at the time the survey could have been done most conveniently we were unable to secure a satisfactory level of consistency in grading by the staff available for this work. A survey of the type planned is a task to be undertaken when practicable.

### *Planting of Rubber*

The upward trend of new planting apparent in the years 1954 to 1956 appears to have been arrested and figures in the Table below are similar in most respects to those of 1956. The apparent decline may be accounted for by reduced staff available to collect information. It seems likely that further increases in the rate of new planting await only the creation of the necessary machinery for obtaining the financial assistance which has been promised for new planting by smallholders.



## NEW PLANTING REPORTED BY RUBBER INSTRUCTORS 1957

| State        | Total new planting | New planting with clonal seedlings | Percentage clonal seedlings | Budgrafting on previous new plantings |
|--------------|--------------------|------------------------------------|-----------------------------|---------------------------------------|
| Selangor     | 16                 | —                                  | —                           | —                                     |
| N. Sembilan  | 165                | 165                                | 100                         | 116                                   |
| Malacca      | 438                | 438                                | 100                         | 20                                    |
| Perak        | 2,635              | 2,521                              | 96                          | 361                                   |
| Johore       | 1,923              | 31                                 | 2                           | 141                                   |
| Pahang       | 1,590              | 1,590                              | 100                         | 790                                   |
| Kedah/Perlis | 2,146              | 1,480                              | 69                          | 389                                   |
| Penang/P.W.  | —                  | —                                  | —                           | —                                     |
| Kelantan     | 1,976              | 1,554                              | 79                          | 795                                   |
| Trengganu    | 392                | 392                                | 100                         | 1                                     |
| Total        | 11,281             | 8,171                              | 72                          | 2,613                                 |

Clonal seedlings have continued the most commonly used planting material but the overall proportion planted with clonal seedlings has declined from 87% in 1956 to 72%. In Johore, however, the use of clonal seedlings has been negligible and in Kedah the decline in use of clonal seedlings has been from 87% to 69% of new planting. A large proportion of Chinese smallholders who are able to undertake new planting are appreciative of the benefits of budding with good clones and this preference accounts for the low use of clonal seedlings in new plantings in Johore and in the over 5 acre class of new planting in Kedah.

Throughout 1957 we have provided for Rubber Instructors to assist smallholders to order supplies of budwood of RRIM 600 Series clones from our Experiment Station. In doing this our object has been to ensure that any planter who wishes to obtain such budwood should be able to do so and should have competent advice on the status of the different clones. No encouragement is given to smallholders to buy budwood of RRIM 600 Series clones and they are warned of the speculative nature of the material. Altogether 2,430 yards of budwood of 600 Series clones were bought by smallholders or owners of small proprietary estates through arrangements made by Rubber Instructors. Nearly half of this budwood was used in Perak and most of this in Upper Perak where progressive Chinese planters are opening up new land. Orders from Kedah and Johore each accounted for one-sixth of the total.

During 1957 a proportion of replantings of 1952 and 1953 have been receiving the final instalment of the replanting grant. The Chief Replanting Officer has kindly arranged for Rubber Instructors to be notified of holdings in their districts which have ceased to be under the care of the Replanting Scheme. In September we undertook a survey of all replantings which had received full payments of grant in two districts of Selangor and part of a third. Altogether 202 replantings were surveyed. From November arrangements were made for the survey to be extended to other districts where fully paid replantings were numerous — Central and South

Kedah and Province Wellesley, Larut and Matang, the Dindings, Negri Sembilan and North Johore. At the end of the year a total of 480 holdings had been investigated in these areas and work was continuing. This survey has been a valuable training exercise for R.R.I. scholars at the College of Agriculture and new Junior Rubber Instructors. A full study of the data accumulated will require time but preliminary scrutiny indicates that standards of development vary widely between and within districts. The records show clearly that in general no thinning out has been done and casual losses have on the whole been small. Stands are now generally too dense for optimum growth and economic production in the future and provision of advice on thinning out will be an important but difficult task. Evidence of root disease was noted in 43% of the holdings examined in Selangor but the proportion in which serious damage had resulted from root disease is low. The state of a few holdings suggests that in a minority of cases in certain districts the present standards of the replanting scheme are not being adequately enforced. Confirmed cases will be drawn to the attention of the Chief Replanting Officer. Further detailed study of the data may enable us, in consultation with the Chief Replanting Officer, to devise standards which are more readily applied uniformly in the field to the benefit of the general level of maintenance.

### *Treatment of Lalang*

In view of poor results obtained when oil based herbicides were used on smallholders' replantings in 1956, field trials with these materials on sheet lalang areas were commenced at the beginning of the year. Despite favourable weather conditions and some high rates of application—maximum 222 gallons per acre of Shell Lalang Oil W in four applications over a period of three months—regeneration remained serious. It is considered from these trials that oil based herbicides at present available do not provide a satisfactory and economic means of controlling lalang on smallholdings.

Information supplied by the Soils Division indicated the promise shown by Dowpon, formerly Dalapon, (the sodium salt of 2, 2-dichloropropionic acid) in controlling lalang. Field trials on smallholdings were therefore laid down in February in which Dowpon was applied to half-acre plots of sheet lalang at the rates of 10, 15 and 20 lb per acre. Given good spraying technique it was found that 20 lb per acre gave complete suppression of lalang for twelve weeks and regeneration after this period was slow and capable of control by wiping with oil. Fifteen pounds per acre gave good initial suppression of lalang and offers good prospects of more economical control provided follow up treatment is efficient; regeneration however was more rapid than with 20 lb per acre.

In view of the proved difficulty of securing constant maintenance of treated areas on smallholdings it was decided to limit demonstration of the use of Dowpon, initially, to 20 lb per acre. From June onwards R.R.I. spraying teams undertook to lay down demonstrations on behalf of the Rubber Industry (Replanting) Board in all States. These demonstration plots were generally 1 acre in extent and 20 lb of Dowpon was applied in 120 gallons of water with 6 oz of wetting agent. A total of 29 demonstrations were established between June and September distributed as follows:

Johore 5; Negri Sembilan 6; Malacca 3; Selangor 2; Pahang 6; Perak 3; Province Wellesley 1; Kedah 2; Kelantan 1.

Some defoliation of young rubber trees has been noted as a result of Dowpon spraying at the level demonstrated but no deaths have resulted and recovery has been relatively rapid. Considering the serious effects of lalang on growth of young plantings it appears to be worth tolerating some mild toxic effect on the trees for certainty in getting rid of lalang. We have however initiated further trials to see whether toxic effects can be avoided by splitting the dose between two sprayings at varied intervals and to test whether additional wetting agent improves the effect of Dowpon at lower rates of application. Increasing the wetting agent shows little promise of improvement and it is too early to say whether double applications will be of value.

There is no doubt that Dowpon is the most effective herbicide so far tested on lalang and offers a reasonable chance of bringing vast areas of smallholders' replanting infested with lalang into a reasonable state of cultivation.

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## INFORMATION

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### *Pilot Instruction Centre, Ayer Pa'abas*

The buildings for our school for rubber smallholders—hostel, Junior Rubber Instructor's house and factory—were completed in May but work on electric light, water and sanitary installations extended into July. The school was finally ready for use early in August and an 'open' day for Penghulus and other interested visitors was held at the end of the first training course on 24 August.

The school was initially designed to accommodate 12 trainees at full courses of four weeks duration. It was quickly apparent that this was inadequate to deal with the demand for training from Malacca and parts of Negri Sembilan. Advantage was, therefore, taken of the spacious structure of the Minangkabau style hostel to build in two extra dormitories on the ground floor each capable of accommodating five persons, thus putting the capacity of the school up to 22. It will be able to provide training each year from 1958 for not less than 200 persons. The work was completed during the last three weeks of December when the school was closed.

The capital cost of establishing the school at Ayer Pa'abas has been:

|                                                | \$            |
|------------------------------------------------|---------------|
| Land, including sub-division and other charges | 8,550         |
| Fencing                                        | 1,500         |
| Buildings (hostel, J.R.I.'s house and factory) | 29,950        |
| Water supply & electric light                  | 7,820         |
| Septic tank                                    | 2,000         |
| Furnishing (house & hostel)                    | 1,780         |
| Equipment                                      | 1,430         |
|                                                | <u>53,030</u> |

This capital cost may be expressed in per caput terms on students benefited. Given a ten year life, which is conservative, 2000 students will receive instruction at a capital cost of \$26.50 per head. Running costs less revenue are estimated at \$4,000



per year during the first ten years and this means a further cost of \$20 per student and a total of \$46.50. Since the smallholder who attends a four week course must find not less than \$50 to cover the cost of food and travelling a continued demand for training will fully justify extension of similar training facilities to other areas.

### Training

The value of systematic training of smallholders in rubber growing has been confirmed by further work in this field. The advantage is clear in having full control of facilities for practical training to provide the maximum experience for trainees. We have however considered it desirable to undertake training courses wherever practicable however inconvenient the facilities available. The system developed originally by the Chinese Rubber Instructor at Batu Pahat in 1954 whereby a class is enrolled and lectures and instructions given on one day per week during six months has been extended to other areas. Rubber Instructors deserve great credit for stimulating and maintaining interest for these courses when the practical work is conducted under difficulty.

Training for smallholders has thus been undertaken in three ways, at the R.R.I. Experiment Station, at our pilot school at Ayer Pa'abas and at three centres where Rubber Instructors have conducted courses for local inhabitants. A record of training completed is presented below:

TRAINING COURSES FOR SMALLHOLDERS — 1957

| Centre                    | No. of courses | Students enrolled | Students completed training | Students awarded certificates |
|---------------------------|----------------|-------------------|-----------------------------|-------------------------------|
| R.R.I. Experiment Station | 4              | 136               | 136                         | 104                           |
| Ayer Pa'abas              | 3              | 36                | 33                          | 21                            |
| Batu Pahat (Chinese)      | 1              | 36                | 29                          | 15                            |
| Batu Pahat (Malays)       | 1              | 20                | 19                          | 9                             |
| Machang (Malays)          | 1              | 35                | 27                          | 19                            |
| Padang Lati (Malays)      | 1              | 19                | 17                          | 9                             |
| <i>Total</i>              | 11             | 282               | 261                         | 177                           |
| <i>Percentage</i>         |                |                   | 92                          | 63                            |

At the end of the year further courses were being conducted by both the Chinese and Malay Instructors at Batu Pahat while the Malay Instructor at Taiping had two courses in hand at Kampong Bagan Bahru and Kampong Batu Tegoh. These courses were providing for a further 116 persons.

Rubber Instructors or Junior Rubber Instructors have at all times been available to provide instruction on rubber growing subjects at the schools of the Department of Agriculture. Such assistance has been called for at Ayer Hitam (Johore), Pekan (Pahang), Cheras (Selangor), Degong (Perak), Kota Bharu (Kelantan) and Gajah Mati (Kedah).

## Smallholders' Advisory Service: Information

The opportunity was taken of the need to train new Junior Rubber Instructors for the S.H.A.S. to offer training to organisations providing assistance to rubber smallholders in Malaya and adjacent territories. A ten-week course was conducted in English from August to October for 24 persons as noted below:

|                                               |    |
|-----------------------------------------------|----|
| R.R.I. staff requirements                     | 13 |
| Department of Agriculture, Sarawak            | 3  |
| Rubber Fund Board, North Borneo               | 2  |
| R.I.D.A.                                      | 4  |
| Tanah Merah Land Development Board (Kelantan) | 2  |

Special training in the subject of planting material generally and particularly on the collection and nursery planting of clonal seeds was provided for 15 Rubber Assistants of the Department of Agriculture during one week at the beginning of August. It is understood that Rubber Assistants will be employed in the work of the pool of planting material.

### *Mobile Cinema Unit*

The cinema unit had an active programme throughout the year although wet weather in November and December inevitably restricted its use to places where screening could be done under cover. It was used principally during these months to support the training courses at our Experiment Station, Ayer Pa'abas, Batu Pahat and the Agricultural school at Ayer Hitam, Johore. The unit was out on tour during 190 days and provided 144 film screenings. All states were covered by one tour of visits while Malacca, Kedah, Perak and Selangor were visited twice.

### *Agricultural Shows*

We were asked to provide exhibits at only three state agricultural shows this year at Kluang (Johore), Alor Gajah (Malacca), and Kota Bharu (Kelantan). Exhibits were set up by the Rubber Instructors on the spot. At the Malayan Agri-Horticultural Association Show at Kuala Lumpur from 5 to 8 July, the S.H.A.S. was responsible for the organisation of the smallholders' rubber competition and for judging the performance of competitors. Perak, Negri Sembilan, Johore and Malacca were represented in this competition but 25 of the thirty competitors came from Selangor. The Kelantan Agricultural Show was held after the M.A.H.A. Exhibition and the Senior Rubber Instructor ran a State sheet-making competition for smallholders which attracted 21 entrants.

The following publications have been received from the printer during the year:

Replanting on Smallholdings, Jawi edition; Good Tapping, English, Jawi, Rumi and Chinese editions; Leaflet — Manuring of Young Rubber, Jawi edition; Budgrafting Poster, Rumi, Chinese and Dyak editions.

At the end of the year Jawi and English editions of the budgrafting poster were still with the printers.

## INVESTIGATIONS

### *Investigation of Planting Methods Applicable to Smallholding Conditions*

A summary of trees in tapping in the various replantings with hedges which were undertaken with partial clearance of the old stand is given below:

| Replanting            | Acreage | No. of trees | Tappable trees |
|-----------------------|---------|--------------|----------------|
| 1948 Clonal seedlings | 0.85    | 145          | 98             |
| 1949 Clonal seedlings | 1.00    | 116          | 42             |
| 1950 Buddings         | 2.25    | 243          | 52             |

These figures indicate that there is considerable retardation of growth in hedge plantings where a proportion of the original stand is maintained between hedges. Without careful supervision the results could be much inferior and it does not seem practicable for any such system to be adopted by smallholders.

Replanting in 1957 was on  $\frac{3}{4}$  acre. Old trees in 18ft rows were felled by sawing at waist height and stumps were treated with 2,4,5-T. Half the area has been planted at 18ft  $\times$  13ft giving 186 points per acre and the other half at 18ft  $\times$  15ft giving 161 planting points per acre. Three seed-at-stake have been planted for field budding. Recent study of smallholders' replantings aged 4 years suggests that, because they are unwilling to practice thinning, smallholders may be well advised to plant a lower stand for budding than has been recommended in the past.

### *Investigation of Costs of Replanting on Smallholdings*

The data being obtained from five case studies of replanting on smallholdings proved unsuitable for providing general guidance on costs, and collection of information has been discontinued.

### *Investigation of Processing and Marketing of Smallholders' Rubber*

No further work has been attempted in this field.

L. R. DAVIDSON  
Smallholders' Advisory Officer



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## SENIOR STAFF AND GRADUATE ASSISTANTS

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### ADMINISTRATION

- C. E. T. Mann, M.Sc., F.I.R.I. *Director*. (First appointed 15 June 1927)  
 C. G. Akhurst, B.Sc., A.R.C.S., A.I.C.T.A. *Deputy Director*. (First appointed 7 October 1930)  
 H. S. Blacklin, *Secretary*. (First appointed 1 March 1932)  
 J. C. Reeves, F.C.C.S. *Assistant Secretary*. (First appointed 11 September 1950)  
 J. A. Faulkner, *Maintenance Engineer*. (First appointed 1 November 1955)

### PUBLICATIONS SECTION

- D. R. Rexworthy, B.Sc., F.R.I.C. *Publications and Information Officer*. (First appointed 23 July 1952). Resigned 7 December.

### STATISTICS SECTION

- D. R. Westgarth, M.Sc. *Statistician*. (First appointed 3 August 1950). Resigned 7 March.  
 Fong Chu Chai, B.Sc., Dip. Arts, *Assistant Statistician*. (First appointed 8 July 1949)  
 G. Chidambara Iyer, M.Sc. *Assistant Statistician*. (First appointed 20 August 1955)

### EXPERIMENT STATION

- R. F. Harley, M.C., F.I.S.P. *Manager*. (First appointed 27 August 1937)  
 A. E. Browne, M.C. *Assistant Manager*. (First appointed 1 February 1948)  
 J. D. Macritchie, B.Sc. (Agri.) *Assistant*. (First appointed 15 December 1954)  
 J. H. Chapman, B.Sc. (Agri.) *Assistant*. (First appointed 19 August 1955)

### SOILS DIVISION

- G. Owen, M.Sc., F.I.S.P. *Head of Division*. (First appointed 5 January 1939)  
 E. W. Bolle-Jones, M.Sc., Ph.D., M.I. Biol. *Plant Physiologist*. (First appointed 20 August 1952). Resigned 5 September.  
 G. A. Watson, M.Sc., Ph.D., A.R.C.S., D.I.C., A.R.I.C. *Soils Chemist*. (First appointed 17 November 1955)  
 V. M. Shorrocks, M.A., D.Phil., M.I. Biol. *Plant Physiologist*. (First appointed 28 August 1957)  
 V. R. Mallikarjuneswara, B.Sc. M.Sc. *Assistant Soils Chemist*. (First appointed 4 April 1955). Resigned 30 June.  
 M. M. Guha, B.Sc., Assoc. I.A.R.I. *Assistant Soils Chemist*. (First appointed 20 May 1955)

### BOTANICAL DIVISION

- C. W. Brookson, B.Sc. *Head of Division*. (First appointed 23 August 1947)  
 P. de Jonge, I.I. *Botanist*. (First appointed 29 December 1950)  
 P. R. Wycherley, Ph.D. *Botanist*. (First appointed 26 January 1953)  
 J. M. Ross, B.Sc. *Botanist*. (First appointed 2 November 1955)  
 S. G. Boatman, Ph.D., *Botanist*. (First appointed 2 November 1956)  
 T. V. Vaidyanathan, B.Agric. *Assistant Botanist*. (First appointed 1 May 1935)  
 V. K. Bhaskaran Nair, M.Sc. *Assistant Botanist*. (First appointed 26 May 1952)  
 Resigned 31 May.

PATHOLOGICAL DIVISION

- A. Newsam, Ph.D. *Head of Division*. (First appointed 5 April 1947)  
F. W. Hutchison, N.D.A., C.D.A. *Field Research Officer*. (First appointed 5 March 1948)  
R. N. Hilton, M.A. *Pathologist*. (First appointed 7 September 1948)  
R. A. Fox, B.Sc., B.Agr. *Microbiologist*. (First appointed 2 March 1954)  
K. P. John, B.A. *Assistant Pathologist*. (First appointed 16 November 1936).  
B. S. Rao, M.A. *Assistant Entomologist*. (First appointed 6 June 1952)

CHEMICAL DIVISION

- W. G. Wren, B.Sc., A.R.C.S., D.I.C., A.I.R.I. *Head of Division*. (First appointed 7 January 1950)  
G. W. Drake, B.Sc., M.A. *Chemist*. (First appointed 8 March 1948)  
W. A. Southorn, Ph.D., A.R.I.C. *Chemist*. (First appointed 18 November 1952)  
J. E. Morris, B.Sc., *Chemist*. (First appointed 20 June 1952)  
H. M. Edmondson, B.Sc., *Technologist*. (First appointed 28 August 1950). Resigned 11 March.  
R. S. Gale, B.Sc., A.C.G.I., A.M.I.Chem.E. *Chemical Engineer*. (First appointed 2 May 1951)  
D. J. Graham, A.S.T.C., A.R.A.C.I., *Chemical Engineer*. (First appointed 31 March 1953)  
D. H. Taysum, M.Sc., D.I.C. *Microbiologist*. (First appointed 13 September 1954)  
G. F. J. Moir, B.Sc. *Biochemist*. (First appointed 2 February 1955)  
B. C. Sekhar, B.Sc., M.S., A.R.I.C. *Chemist*. (First appointed 15 September 1949)  
C. A. K. Salgado, B.Sc. *Technologist*. (First appointed 22 April 1957)  
T. V. Molesworth, B.Sc. (Tech.), A.M.I.Chem.E. *Chemical Engineer*. (First appointed 22 April 1957)  
K. C. Sekar, B.A., A.I.R.I., *Assistant Chemist*. (First appointed 1 October 1928)  
R. C. H. Hsia, B.Sc. *Assistant Chemist*. On study course in England. (First appointed 2 January 1953)  
S. J. Tata, B.Sc. *Assistant Chemist*. (First appointed 14 December 1953)  
ST. Sethu, B.E.(Chem.) *Assistant Chemical Engineer*. On study course in England. (First appointed 1 September 1955)

SMALLHOLDERS' ADVISORY SERVICE

- L. R. Davidson, B.Sc. (Agric.) *Smallholders' Advisory Officer*. (First appointed 1 December 1940)  
J. M. F. Greenwood, B.Sc. (Agric.) *Assistant Smallholders' Advisory Officer*. (First appointed 25 November 1948)  
Shamsuddin bin Yub Ahmad, B.Agr. *Assistant Smallholders' Advisory Officer*. (First appointed 1 May 1938)  
J. G. Samuel B.Sc. (Agric.) *Assistant Smallholders' Advisory Officer*. (First appointed 1 May 1939)





# BALANCE SHEET AS

| LIABILITIES                                                                                                     |                  | 31.12.57          | As at<br>31.12.56 |
|-----------------------------------------------------------------------------------------------------------------|------------------|-------------------|-------------------|
|                                                                                                                 | \$ c             | \$ c              | \$                |
| SUNDRY CREDITORS                                                                                                |                  |                   |                   |
| Staff                                                                                                           | 43,613.12        |                   |                   |
| Merchants                                                                                                       | 235,450.00       |                   |                   |
| Miscellaneous                                                                                                   | <u>13,761.55</u> | 292,824.67        | 472.497           |
| STAFF CONTINGENCY RESERVE FUND                                                                                  |                  |                   |                   |
| As at 31 December, 1956                                                                                         |                  | 330,000.00        | 330,000           |
| RESERVE FOR GRATUITIES FOR EQUALISATION<br>OF PROVIDENT FUND CONTRIBUTIONS                                      | 48,897.18        |                   | 27,720            |
| <b>Less</b> Investment of these Funds in<br>the Post Office Savings Bank                                        | <u>48,897.18</u> | —                 | 27,720            |
| EXCESS OF ASSETS OVER LIABILITIES                                                                               |                  |                   | —                 |
| As at 31 December, 1956                                                                                         | 3,885,400.69     |                   |                   |
| <b>Less</b> Refund to Malayan<br>Rubber Fund                                                                    | \$92,101.30      |                   |                   |
| Government Rubber<br>Replanting Scheme<br>Grant for 1955<br>transferred to<br>Experiment Station<br>Development | 10.075.00        |                   |                   |
| Original Cost of<br>Replanted Areas<br>transferred from<br>Experiment Station<br>Development                    | <u>52,122.46</u> | <u>154,298.76</u> |                   |
|                                                                                                                 |                  | 3,731,101.93      |                   |
| <b>Add</b> Excess of Income over<br>Expenditure for the year:                                                   |                  |                   |                   |
| Head Office                                                                                                     | 396,387.65       |                   |                   |
| Experiment Station                                                                                              | 180,357.20       | <u>576,744.85</u> | 4,307,846.78      |
|                                                                                                                 |                  |                   | 3,885,400         |

**Carried forward**

4,930,671.45

4,687,897

| ASSETS                                                              |                  | 31.12.57          | As at<br>31.12.56 |
|---------------------------------------------------------------------|------------------|-------------------|-------------------|
| LAND AND BUILDINGS                                                  | \$ c             | \$ c              | \$                |
| <b>2¼ Mile Compound</b>                                             |                  |                   |                   |
| Land as at 31 December 1956                                         | 15,784.35        |                   |                   |
| 198 and 200 Ampang Road:<br>At nominal value                        | <u>2.00</u>      | 15,786.35         | 15,786            |
| <b>3rd Mile Compound</b>                                            |                  |                   |                   |
| Land as at 31 December 1956                                         | 31,440.35        |                   |                   |
| 251, 253, 255, 257, 259 and 261<br>Ampang Road:<br>At nominal value | <u>6.00</u>      | 31,446.35         | 31,446            |
| <b>3¼ Mile Compound</b>                                             |                  |                   |                   |
| Land as at 31 December 1956                                         | 27,582.50        |                   |                   |
| 262, 264, 266, 268 and 270<br>Ampang Road:<br>At nominal value      | <u>5.00</u>      | 27,587.50         | 27,588            |
| <b>4th Mile Compound</b>                                            |                  |                   |                   |
| Land as at 31 December 1956                                         | 2,000.00         |                   |                   |
| 73, 4th Mile Ampang Road:<br>At nominal value                       | <u>1.00</u>      | 2,001.00          | 2,001             |
| <b>Eaton Road Compound</b>                                          |                  |                   |                   |
| Land as at 31 December 1956                                         | 17,147.08        |                   |                   |
| 1, 3, 5 and 7 Eaton Road:<br>At nominal value                       | <u>4.00</u>      | 17,151.08         | 17,151            |
| <b>Wickham Road &amp; Ridley Close</b>                              |                  |                   |                   |
| Land as at 31 December 1956                                         | 43,623.50        |                   |                   |
| 9 Bungalows — At nominal value                                      | <u>9.00</u>      | 43,632.50         | 43,633            |
| <b>Ulu Klang</b>                                                    |                  |                   |                   |
| Land as at 31 December 1956                                         | 7,705.00         |                   |                   |
| Workmen's Quarters:<br>At nominal value                             | <u>1.00</u>      | 7,706.00          | 7,706             |
| <b>Ampang Road Laboratories</b>                                     |                  |                   |                   |
| Land as at 31 December 1956                                         | 19,526.00        |                   |                   |
| Buildings — As at<br>31 December 1956                               | <u>519.20</u>    |                   |                   |
|                                                                     | 20,045.52        |                   |                   |
| Additions during year                                               | <u>74,813.63</u> | 94,859.15         | 20,045            |
| <b>Carried forward</b>                                              |                  | <u>240,169.93</u> | <u>165,356</u>    |

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|                        |              |                 |
|------------------------|--------------|-----------------|
|                        |              | <b>As at</b>    |
|                        |              | <b>31.12.56</b> |
|                        | \$ c         | \$              |
| <b>Brought forward</b> | 4,930,671.45 | 4,687,897       |

|                        |              |           |
|------------------------|--------------|-----------|
| <b>Carried forward</b> | 4,930,671.45 | 4,687,897 |
|------------------------|--------------|-----------|



|                                               |                 |              | As at<br>31.12.56 |
|-----------------------------------------------|-----------------|--------------|-------------------|
|                                               |                 | \$ c         | \$                |
| LAND & BUILDINGS (Contd)                      | Brought forward | 240,169.93   | 165,356           |
| <b>Sungei Buloh</b>                           |                 |              |                   |
| <b>Laboratories &amp; Houses</b>              |                 |              |                   |
| As at 31 December 1956                        |                 |              |                   |
| At nominal value:                             |                 |              |                   |
| Laboratories                                  | 1.00            |              |                   |
| Houses                                        | 24.00           | 25.00        | 25                |
| <b>Land &amp; Quarters for</b>                |                 |              |                   |
| <b>Rubber Instructors</b>                     |                 |              |                   |
| As at 31 December 1956                        | 115,225.02      |              |                   |
| Additions during year                         | 133,773.32      | 248,998.34   | 115,225           |
| <b>Pilot Instruction Centre</b>               |                 |              |                   |
| As at 31 December 1956                        | 13,917.11       |              |                   |
| Additions during the year                     | 35,177.76       | 49,094.87    | 13,917            |
| PLANT & MACHINERY. At nominal value           |                 | 1.00         | 1                 |
| FURNITURE                                     |                 |              |                   |
| <b>Residential Houses,</b>                    |                 |              |                   |
| <b>Kuala Lumpur</b>                           |                 |              |                   |
| At nominal value                              |                 | 1.00         | 1                 |
| <b>Sungei Buloh</b>                           |                 |              |                   |
| At nominal value                              |                 | 1.00         | 1                 |
| <b>Offices, Kuala Lumpur</b>                  |                 |              |                   |
| At nominal value                              |                 | 1.00         | 1                 |
| <b>Library</b>                                |                 |              |                   |
| At nominal value                              |                 | 1.00         | 1                 |
| <b>Laboratories</b>                           |                 |              |                   |
| At nominal value:                             |                 |              |                   |
| Kuala Lumpur                                  | 1.00            |              |                   |
| Sungei Buloh                                  | 1.00            | 2.00         | 2                 |
| APPARATUS & GLASSWARE. At nominal value       |                 | 1.00         | 1                 |
| MOTOR VEHICLES. At nominal value              |                 | 1.00         | 1                 |
| WORKSHOP. At nominal value                    |                 | 1.00         | 1                 |
| LIBRARY BOOKS & PERIODICALS. At nominal value |                 | 1.00         | 1                 |
| EXPERIMENT STATION DEVELOPMENT                |                 |              |                   |
| As at 31 December 1956                        | 2,355,272.17    |              |                   |
| Additions during year                         | 322,196.39      |              |                   |
|                                               | 2,677,468.56    |              |                   |
| Less Original Cost of                         |                 |              |                   |
| Replanting Areas                              | 52,122.46       |              |                   |
|                                               | 2,625,346.10    |              |                   |
| Less Government Rubber                        |                 |              |                   |
| Replanting Scheme todate                      | 16,400.00       | 2,608,946.10 | 2,355,272         |
| Carried forward                               |                 | 3,147,245.24 | 2,649,806         |

|                 |              |                     |
|-----------------|--------------|---------------------|
|                 |              | As at<br>31.12.1956 |
|                 | \$ c         | \$                  |
| Brought forward | 4,930,671.45 | 4,687.897           |

REPORT OF THE AUDITORS TO THE BOARD OF THE RUBBER  
RESEARCH INSTITUTE OF MALAYA

We have examined the above Balance Sheet with the books and vouchers of the Institute and have obtained all the information and explanations we have required.

Titles to certain of the Institute's lands have not yet been issued.

Subject to the foregoing, in our opinion, the said Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs at 31 December 1957 according to the best of our information and the explanations given to us and as shown by the books of the Institute.

Kuala Lumpur  
16 April 1958

Sgd Peat, Marwick, Mitchell & Co.  
Chartered Accountants  
Auditors

S4,930,671.45

S4,687,897

|                                                      |                  |                       | As at<br>31.12.56  |
|------------------------------------------------------|------------------|-----------------------|--------------------|
|                                                      |                  |                       | \$ c               |
| STOCKS                                               | Brought forward  | 3,147,245.24          | 2,649,806          |
| <b>Petrol, Oil &amp; Chemicals</b>                   |                  |                       |                    |
| Head Office                                          | 200.54           |                       | 279                |
| Experiment Station                                   | <u>1,968.34</u>  | 2,168.88              | 8,955              |
| <b>Empty Containers &amp; Drums</b>                  |                  |                       |                    |
| Head Office                                          | 220.50           |                       | 217                |
| Experiment Station                                   | <u>2,092.00</u>  | 2,312.50              | 2,160              |
| <b>Stationery</b>                                    |                  |                       |                    |
| Head Office                                          |                  | 9,563.42              | 7,335              |
| <b>Sundry Materials</b>                              |                  |                       |                    |
| Head Office                                          | 15,445.99        |                       | 14,253             |
| Experiment Station                                   | <u>22,899.80</u> | 38,345.79             | 16,387             |
| <b>Rubber</b>                                        |                  |                       |                    |
| Experiment Station                                   | <u>41,012.17</u> | 93,402.76             | 65,071             |
| SUNDRY DEPOSITS                                      |                  | 280.00                | 114,657            |
| SUNDRY DEBTORS                                       |                  |                       | 170                |
| <b>Staff</b>                                         |                  |                       |                    |
| Loans for Motor Vehicle                              |                  |                       |                    |
| Purchase                                             | 218,233.61       |                       | 163,866            |
| Travelling & Sundries                                | <u>21,327.00</u> | 239,560.61            | 20,325             |
| <b>General</b>                                       |                  |                       |                    |
| Head Office                                          | 166,563.39       |                       | 159,414            |
| Experiment Station                                   | <u>2,084.38</u>  | 168,647.77            | 10,983             |
| <b>Interest Accrued on Investments</b>               |                  | 7,136.16              | 6,383              |
| <b>Payment in Advance</b>                            |                  |                       |                    |
| Head Office                                          | 25,825.02        |                       | 5,989              |
| Experiment Station                                   | <u>4,722.80</u>  | <u>30,547.82</u>      | 8,358              |
| LOCAL AND BRITISH GOVERNMENT SECURITIES              |                  |                       |                    |
| (Held for account of Staff Contingency Reserve Fund) |                  |                       | 375,318            |
| \$ 15,000/- 4½% Singapore Municipal                  |                  |                       |                    |
| Debenture Stock 1930-70/80                           |                  | 15,000.00             | 15,000             |
| (\$17,537†) (\$12,149*)                              |                  |                       |                    |
| \$ 40,000/- 3% F.M.S. Government                     |                  |                       |                    |
| War Loan 1940-52/59                                  |                  | 40,000.00             | 40,000             |
| (\$40,000†) (\$37,600*)                              |                  |                       |                    |
| \$160,000/- 3% Malayan Union                         |                  |                       |                    |
| Government Loan 1946-62/66                           |                  | 160,000.00            | 160,000            |
| (\$160,000†) (\$124,966*)                            |                  |                       |                    |
| £ 20,600/- 3½% British War Loan 1952                 |                  |                       |                    |
| purchased during the year                            |                  | 145,322.05            | 145,322            |
| (\$145,322†) (\$110,799*)                            |                  |                       |                    |
| † Original Cost — \$362,859                          |                  |                       |                    |
| * Market Value as at 31                              |                  |                       |                    |
| December 1957 — \$285,544                            |                  |                       |                    |
| CASH AT BANK AND IN HAND                             |                  |                       |                    |
| <b>At Bank</b>                                       |                  |                       |                    |
| Fixed Deposit                                        | 258,845.95       |                       |                    |
| Current Account                                      | 619,163.52       |                       |                    |
| <b>In Hand</b>                                       | <u>5,519.57</u>  | 883,529.04            | 1,187,624          |
|                                                      |                  | <u>\$4,930,671.45</u> | <u>\$4,687,897</u> |



# Income & Expenditure Account (excluding Experi

| To                                                | EXPENDITURE         | As at<br>31.12.56 |                  |
|---------------------------------------------------|---------------------|-------------------|------------------|
|                                                   |                     | \$                | c                |
| International Rubber Research Board/International |                     |                   |                  |
| Rubber Development Committee                      | —                   |                   | 4,464            |
| London Advisory Committee                         | 20,629.03           |                   | 22,194           |
| Board Meetings                                    | 2,868.05            |                   | 2,637            |
| Salaries of Staff on Agreement                    | 574,113.73          |                   | 508,703          |
| Salaries of Staff not on Agreement                | 1,107,194.56        |                   | 1,011,876        |
| Provident Fund                                    | 189,866.81          |                   | 170,387          |
| Medical                                           | 30,807.05           |                   | 20,987           |
| Travelling                                        | 79,499.44           |                   | 63,648           |
| Office General Charges                            | 44,624.54           |                   | 37,054           |
| Rents, Rates & Taxes                              | 15,247.23           |                   | 13,251           |
| Insurance                                         | 24,231.03           |                   | 27,291           |
| Laboratory General Charges                        | 7,453.45            |                   | 7,730            |
| Buildings & Grounds                               | 98,907.37           |                   | 148,409          |
| Furniture & Office Equipment                      | 30,131.85           |                   | 71,671           |
| Fixtures & Fittings                               | 47,200.94           |                   | 31,218           |
| Plant & Machinery                                 | 150,919.42          |                   | 108,578          |
| Vehicles Maintenance                              | 20,529.58           |                   | 11,978           |
| Workshop                                          | 17,534.73           |                   | 26,117           |
| Apparatus & Glassware                             | 122,964.44          |                   | 155,117          |
| Laboratory Chemicals                              | 38,627.95           |                   | 24,060           |
| Publications                                      | 23,371.25           |                   | 20,724           |
| Library (Books & Periodicals)                     | 20,732.16           |                   | 15,230           |
| Exhibitions                                       | 5,141.78            |                   | 7,406            |
| Smallholders' Advisory Service                    | 545,753.98          |                   | 568,113          |
| Field & Factory Experiments                       | 122,775.20          |                   | 64,694           |
| Technical Classification                          | 34,102.53           |                   | 22,340           |
| Gratuities to Staff                               | 22,492.00           |                   | 20,000           |
| Leave Pay                                         | 192,758.13          |                   | 101,974          |
| Passages                                          | 110,284.82          |                   | 40,108           |
| Grant towards Passages                            | 1,394.35            |                   | 3,853            |
| Scholarship                                       | 1,529.29            |                   | —                |
|                                                   | <u>3,703,686.69</u> |                   | <u>3,331,812</u> |
| Excess of Income over Expenditure for the year    | 396,387.65          |                   | 464,462          |
|                                                   | <u>4,100,074.34</u> |                   | <u>3,796,274</u> |

## Income & Expenditure Account for Experi

| To                                             | EXPENDITURE |                   |                |
|------------------------------------------------|-------------|-------------------|----------------|
|                                                |             | \$                | c              |
| Revenue Expenditure                            |             | 784,706.27        | 712,447        |
| Excess of Income over Expenditure for the year |             | 180,357.20        | 225,170        |
|                                                |             | <u>965,063.47</u> | <u>937,617</u> |

ion) for the year ended 31 December 1957

| By                                                  | INCOME | As at<br>31.12.56   |                  |
|-----------------------------------------------------|--------|---------------------|------------------|
|                                                     |        | \$ c                | \$               |
| Contributions received from The Malayan Rubber Fund |        | 4,000,000.00        | 3,707,426        |
| Publications Sold                                   |        | 13,767.12           | 9,883            |
| Rents on Houses                                     |        | 22,555.68           | 17,712           |
| Interest on Loans                                   |        | 3,355.31            | 2,162            |
| Interest on Investments                             |        | 30,008.06           | 26,561           |
| Miscellaneous                                       |        | 30,388.17           | 32,530           |
|                                                     |        | <u>4,100,074.34</u> | <u>3,796,274</u> |

on for the year ended 31 December 1957

| By                                                     | INCOME | As at<br>31.12.56 |                |
|--------------------------------------------------------|--------|-------------------|----------------|
|                                                        |        | \$ c              | \$             |
| Sales and Stock of Rubber                              |        | 857,776.35        | 827,442        |
| Sales of Replanting Materials                          |        | 58,544.15         | 37,813         |
| Miscellaneous                                          |        | —                 | 166            |
| Rubber Industry (Replanting) Board:                    |        |                   |                |
| Refund on account of Replanting Cesses                 |        | 26,994.09         | 51,247         |
| Refund on account of Anti-Inflationary Cesses          |        | 21,748.88         | 10,874         |
| Government Rubber Replanting Scheme for Estates:       |        |                   |                |
| Grant under the Government Scheme<br>for the year 1955 |        | —                 | 10,075         |
|                                                        |        | <u>965,063.47</u> | <u>937,617</u> |







